INSTRUCTION MANUAL

MODEL 337

DIGITAL PHASE GENERATOR

EXACT ELECTRONICS, INC.
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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

WAVEFORMS

Sine, square, triangle, ramp, pulse, and sync.

DYNAMIC FREQUENCY RANGE

0.00001 Hz (10μHz) to 50 kHz
0.000001 Hz (1μHz) to 1 kHz (Option B)

SYNC OUTPUT

Square wave approximately 4V P-P open circuit.
100 Ohm output impedance.

FREQUENCY MULTIPLIER (Kelvin-Varley Divider) ACCURACY

± (1% of setting + 1% of range).

REFERENCE AND VARIABLE PHASE OUTPUTS

50 Ohms output impedance.
All waveforms 20V P-P Open circuit,
10V P-P into 50 Ohms.
A full 80dB of attenuation is provided with 10dB steps and 20dB continuously variable.

VCF (Voltage-Controlled Frequency)

Approx. 5V input for 1000:1 (three decades) frequency ratio.

PHASE LEAD ACCURACY

Variable Phase Output related to Reference output; ±0.2° (with both generators on the same symmetrical waveform 0.0001 Hz to 5 kHz) adjustable in 0.2° increments from 0° to 360°.

SINE WAVE DISTORTION

< 0.5% 0.00001 Hz to 5 kHz
< 1% to 50 kHz

SINE FREQUENCY RESPONSE

±0.1dB to 1 kHz
±0.25dB to 50 kHz

SQUARE WAVEFORM

Rise and fall 1 microsec. Overshoot and ringing 5%.

TRIANGLE LINEARITY

99% to 5 kHz

DC OFFSET

± 5V into 50 Ohms, ± 10V open circuit. Note DC offset plus signal cannot exceed maximum voltage output or clipping will occur.

FREQUENCY STABILITY
0.05% of setting for 10 min.
0.25% of setting for 24 hours.

AMPLITUDE STABILITY (including hold mode)
0.02% of max P-P amplitude for 10 min.,
0.05% of max P-P amplitude for 24 hrs.

NOTE: All stabilities are for constant line voltage and temperature and do not apply in the search mode of operation. All specifications are for both Reference and Variable phase outputs unless otherwise noted.

SYMMETRY (Time)
99%

REAR PANEL
REFERENCE AND VARIABLE PHASE OUTPUTS
Parallels front panel outputs.

REFERENCE AND VARIABLE PHASE SYNC OUTPUTS
Approx 3V P-P square wave. Approx 100Ω output impedance.

REFERENCE AND VARIABLE PHASE DC OFFSET INPUT
Gain approx -1. Input impedance approx 600Ω

EXTERNAL HOLD INPUT
Approx -2V hold waveform level present upon application

TRIGGER INPUT
Sensitivity adjustable from front panel from approx 1.5V to 15V.

VCF INPUT
Approx 0 to +5V sweeps up 3 decades (1000:1). Input impedance approx 10K.

EXTERNAL CLOCK INPUT
Input level approx ± 2V.

CLOCK OUTPUT
Output levels approx ±2V.

PHASE OUTPUT
Provides sync pulse coincident with zero crossing of reference generator.

POWER REQUIREMENTS
Input Voltage - 115VAC ± 10% or 220 VAC ± 10%. Frequency - 50 to 60 Hz, Power consumption 80W.

NOTE: (unless otherwise stated). Specifications apply from 10% to full amplitude with output terminated into 50 Ω and do not apply in the Search Mode. Specifications are valid at 25°C±5°C and with 105-125 VAC or 200-240 VAC line voltage applied.

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VERIFICATION OF SPECIFICATIONS

It is recommended that the instrument be operated with covers in place for a period of 1 hr. before verification of specifications

The following test equipment of suitable equivalents of known accuracy are required for complete specifications validation for the Model 337 Waveform Generator.

Oscilloscope
Tektronix 544 or equivalent
Differential Input with 5mv/cm sensitivity
Tektronix W Type Plug-in or equivalent
Counter-Timer 50KHz - 100,000 seconds
DANA 8010B or equivalent
DVM, .01% accuracy with 1,000 meg ohm floating input
DANA 4300 or equivalent
Harmonic Distortion Analyzer less than .1% residual distortion
Hewlett-Packard 333 or equivalent

Preset all the front panel controls as follows:

VARIABLE PHASE	
FUNCTION	Square
AMPLITUDE	Fully clockwise
OFFSET	Disengaged
ATTENUATOR	Disengaged
PHASE LEAD	0°
REFERENCE	
FUNCTION	Square
AMPLITUDE	Fully clockwise
OFFSET	Disengaged
ATTENUATOR	Disengaged
RUN	Engaged
GATE	Disengaged
HOLD	Disengaged
10:1 SYM	Disengaged

ALL STEPS REFER TO VARIABLE PHASE GENERATOR

FREQUENCY ACCURACY: To measure the frequency accurately all frequency measurements below 1 kilohertz are expressed in period time and all above in hertz. With the counter connected to main output:

Mult.	Range	Actual Setting	Accuracy	Generator should be within
1.0X	.0001	.0001 Hz	±(1% of setting + 1% of Range)	10200 Sec. to 9800 sec.
.10X	.0001	.00001 Hz	"	111000 Sec. to 89000 Sec.
1.0X	.001	.001Hz	"	1020 to 980 "
.10X	.001	.0001Hz	"	11100 to 8900 "
1.0X	.01	.01Hz	"	102 to 98 "
.10X	.01	.001Hz	"	1110 to 890 "
1.0X	.1	.1Hz	"	10.2 to 9.8 "
.10X	.1	.01Hz	"	111 to 89 "
1.0X	1	1.0Hz	"	1.02 to .98 "
.10X	1	.10Hz	"	11.1 to 8.90 "
1.0X	10	10Hz	"	.102 to .098 "
.10X	10	1.0Hz	"	1.11 to .890 "
1.0X	100	100Hz	"	10.2ms to 9.80ms
10X	100	10Hz	"	111ms to 89.0ms
1.0X	1K	1KHz	"	1.02ms to .980ms
.10X	1K	100Hz	"	11.1ms to 8.90ms
1.0X	5K	5KHz	"	4.90KHz to 5.1KHz
.10X	5K	500Hz	"	.445KHz to .55Khz
1.0X	50K	50KHz	"	49.0KHz to 51.0KHz
.10X	50K	5KHz	"	4.45KHz to 5.55KHz

SINE DISTORTION: Return the Function Selector to Sine wave and also check to see that generator frequency is set for 100Hz. Amplitude Control should be set for mid range.

1. Connect Distortion Analyzer to the Output Connector terminated into 50Ω. Measure the sine distortion of less than .5% typically .2%.

SINE FREQUENCY RESPONSE: Set the Range to 1KHz and connect the oscilloscope to output connector.

1. Observe sine wave amplitude.

2. Set Range to 50KHz. Observe sine amplitude drop less than .1db.

SQUARE WAVEFORM: Set Function Switch to Square. Set Amplitude Control for an output voltage of 10V peak to peak or less into 50 Ohms.

1. Observe the rise and fall time to be less than or equal to 1 microsecond.

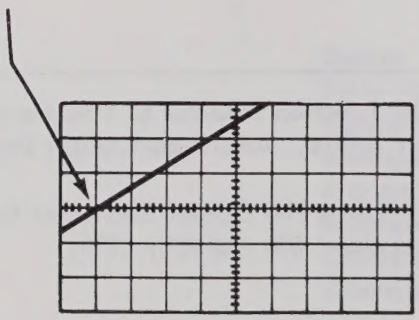
2. Observe that the overshoot and ringing are less than 5% of maximum peak to peak amplitude.

TRIANGLE LINEARITY: Set Range to 1K. Set the Function to Triangle. Monitor the Output with the oscilloscope.

1. Adjust the oscilloscope to obtain 1/2 cycle of the triangular waveform across the full horizontal grid on the oscilloscope CRT.

2. Reset the Differential Plug-in to a sensitivity of 20 millivolts per centimeter.

3. Adjust the comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.



TRIANGLE LINEARITY: (Continued)

4. Record reference voltage using the DVM accurate to 1 millivolt.

5. Adjust the comparison voltage until slope of triangle intersects next major horizontal grid mark.

6. Record accurately the new reference voltage.

7. Repeat to obtain as many points as desired.

8. Calculate linearity and observe linearity is within specifications.

FREQUENCY STABILITY: Connect Frequency Counter to main output terminated into 50Ω. Measure frequency accurately. Note the frequency reading. Wait 10 minutes. Measure frequency again and note that frequency change should be less than .05%. Wait 24 hrs. Measure frequency again and note reading remains within .25%.

AMPLITUDE STABILITY: Set Amplitude control to maximum, set Function to triangle. Connect output, terminated into 50Ω, to Scope and measure the positive and negative peaks. Wait 10 minutes and repeat; observe output changes less than 1mv or .02%. Wait 24 hours and repeat. Observe amplitude changes less than 2.5mv or .05%.

REPEAT ALL THE ABOVE STEPS FOR REFERENCE GENERATOR

PHASE ACCURACY: Set both function switches to square. Connect both outputs to A and B inputs to counter. Set period for 360.0 msec. Observe that for any phase setting the period A to B reads out the phase ±0.2°.

SECTION 2

OPERATING INSTRUCTIONS

2.1 FRONT PANEL FAMILIARITY (Figure 2.1)

1. POWER SWITCH

2. PILOT LIGHT

VARIABLE PHASE GENERATOR

3. FUNCTION - Selects square, triangle or sine for output.

4. AMPLITUDE - Controls amplitude at output over 20db range.

5. D.C. OFFSET - Sets D.C. offset for output. Settable over ±5V range.

6. VAR PHASE OUTPUT - 50Ω output impedence.

7. ATTENUATOR - Step attenuator for output (10db to 60db).

8. OFFSET VARIABLE - Engages D.C. Offset control (see 5).

9. OFFSET POS - Presets an offset in output that sets the bottom of the waveform at ground.

10. OFFSET INV - Inverts Pos offset (see 9).

11. VAR PHASE SYNC OUT - Provides a 3V P-P square wave coincident with peaks of VAR PHASE OUTPUT (100Ω output impedence).

12. PHASE LEAD - Sets the phase in degrees that the variable phase output leads the reference output.

REFERENCE GENERATOR

13. FUNCTION - Selects square, triangle or sine for output.

14. AMPLITUDE - Controls amplitude at output over 20db range.

15. D.C. OFFSET - Sets D.C. offset for output. Settable over ±5V range.

16. REFERENCE OUTPUT - 50Ω output impedence.

17. ATTENUATOR - Step attenuator for output (10db to 60db).

18. OFFSET VARIABLE - Engages D.C. Offset control (see 5).

19. OFFSET POS - Presets an offset in output that sets the bottom of the waveform at ground.

2.1 FRONT PANEL FAMILIARITY (Continued)

20. OFFSET INV - Inverts Pos offset (see 9)

21. REFERENCE SYNC OUT - Provides a 3V P-P square wave coincident with peaks of VAR PHASE OUTPUT (100Ω output impedence).

22. RANGE - Sets frequency range from 100μHz - 5KHz.

23. FREQUENCY MULTIPLIER - Sets frequency below range setting. Frequency will be RANGE x FREQUENCY MULTIPLIER. The search position allows for going three decades below RANGE setting.

24. RUN - Instrument free runs when RUN is engaged and is triggerable when disengaged.

25. MAN - Instrument run through one cycle when MAN is depressed.

26. GATE - With GATE engaged instrument free runs when either MAN is depressed or when the external trigger signal voltage is above the trigger level setting (Sec. 27 and 28).

27. TRIG IN - Input for triggering signal. 10KΩ input impedence.

28. TRIG LEVEL - Sets voltage of TRIG IN at which instrument is triggered.

29. HOLD - When depressed all waveforms are caught and held until HOLD is released. NOTE: The phase lead will be maintained when HOLD is released.

30. 10:1 SYM - Cuts the fall time by a factor of 10, thus providing ramps and pulse. NOTE: PHASE LEAD setting must be interpreted differently in this mode. (see first time operation)

31. VCF INPUT - Voltage Controlled Frequency input. Output frequency will be:

$$\frac{\text{VCF VOLTAGE X RANGE}}{5}$$

When Frequency multiplier is at bottom of search, Usable input range is 0V to +5V

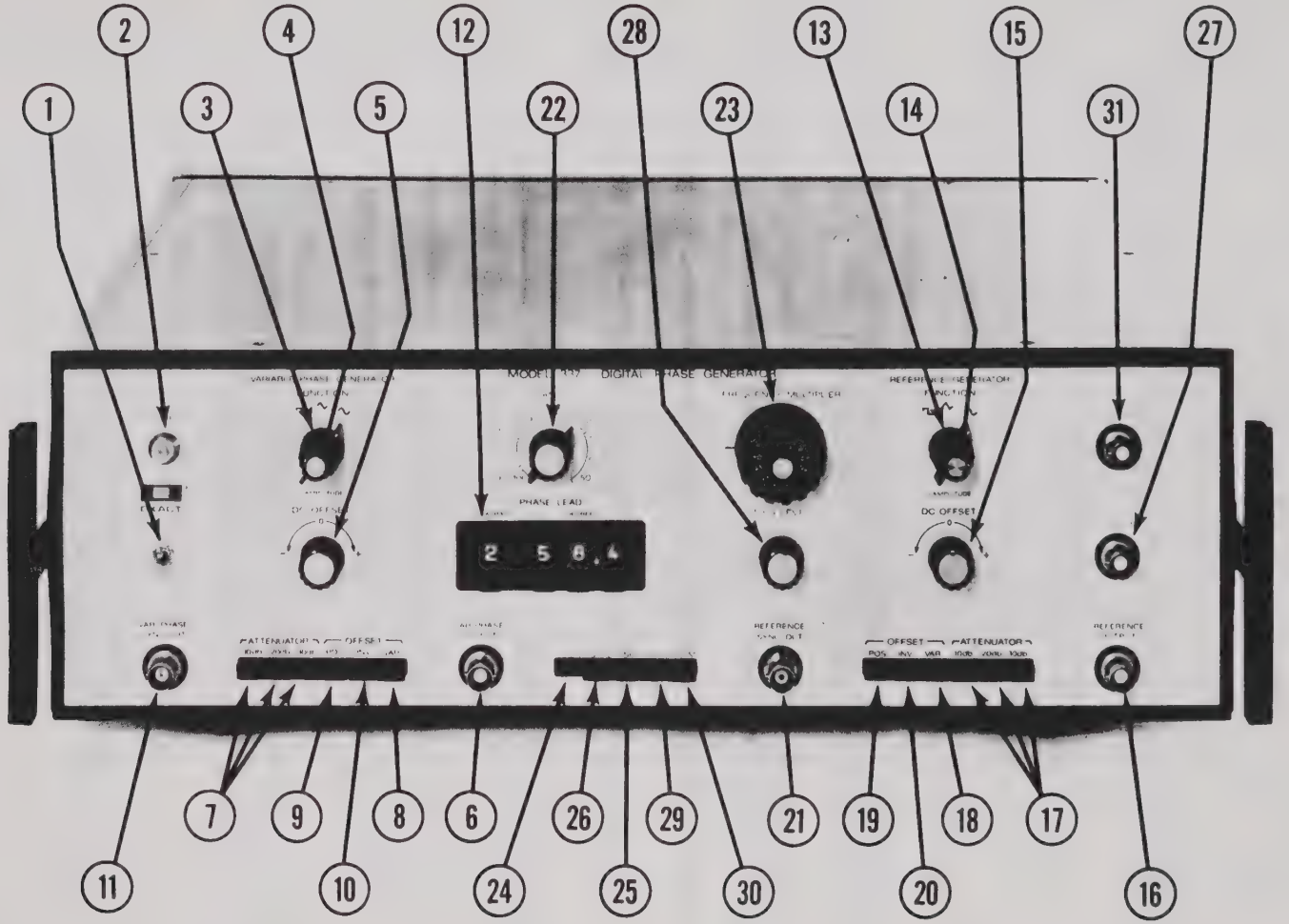


FIGURE 2.1.0 MODEL 337
FRONT PANEL FAMILIARITY

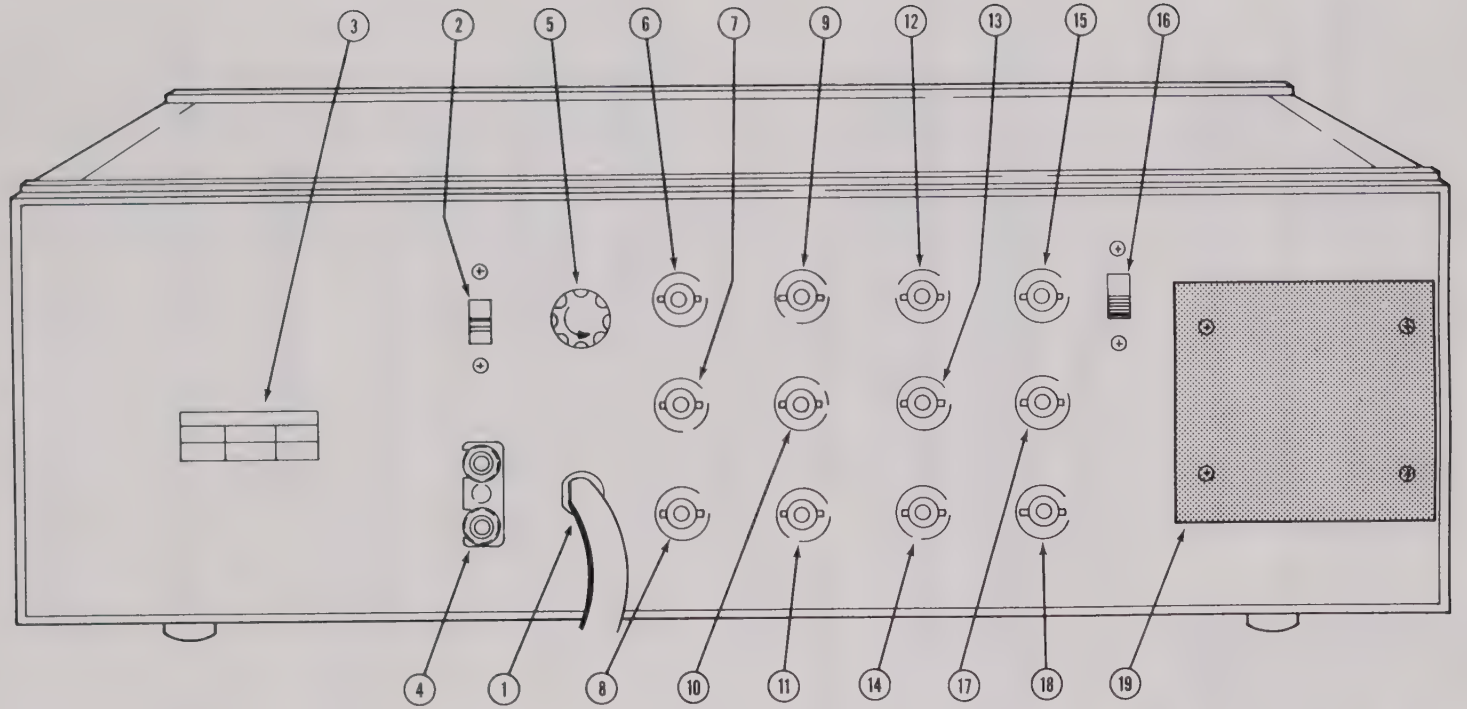


FIGURE 2.2.0 MODEL 337
REAR PANEL FAMILIARITY

2.2 REAR PANEL FAMILIARITY

1. POWER CORD
2. LINE VOLTAGE SELECTOR - Select either 110V or 220V line voltage.
3. FUSE DATA - Shows fuse requirements for 110V and 220V operation.
4. CIRCUIT COMMON - Allows for floating operation of instrument.
5. FUSE HOLDER
6. REFERENCE OUTPUT - 50Ω output impedence.
7. REFERENCE SYNC OUT - Provides a 3V P-P square wave coincident with peaks of REF PHASE OUTPUT (100Ω output impedence).
8. REFERENCE GENERATOR EXTERNAL D.C. OFFSET - Allows for externally controlled D.C. offset. (1V in gives -1V of offset, 562Ω input impedence).
9. VARIABLE PHASE OUTPUT - 50Ω output impedence.
10. VARIABLE PHASE SYNC OUT - Provides a 3V P-P square wave coincident with peaks of VAR PHASE OUTPUT (100Ω output impedence).
11. VARIABLE PHASE GENERATOR EXTERNAL D.C. OFFSET - Allows for externally controlled D.C. offset. (1V in gives -1V of offset, 562Ω input impedence).
12. EXTERNAL HOLD - Allows for externally holding all waveforms. A -2V pulse will cause a hold and will continue to hold as long as the pulse is low.
13. TRIG IN - Input for triggering signal. 10KΩ input impedence.
14. VCF INPUT - Voltage Controlled Frequency input.
    Output frequency will be:

$$\frac{\text{VCF VOLTAGE X RANGE}}{5}$$

When Frequency multiplier is at bottom of search. Usable input range is 0V to +5V

2.2 REAR PANEL FAMILIARITY (Continued)

15. EXTERNAL CLOCK - Allows for using an external clock. TTL levels minus 2V.

The output frequency is related to the clock as follows:

RANGE SETTING	FREQUENCY
50KHz	Clock/180
5KHz	Clock/1800
1KHz	Range x Clock x $\frac{10^{-6}}{9}$

16. EXT/INT CLOCK SWITCH - Selects INT or EXT clock.

17. CLOCK OUTPUT - Output for divided clock. Output frequency is always 1/1800 of this clock except in 50KHz RANGE where it is 1/180.

18. PHASE OUTPUT - Provides a sync pulse.

19. COOLING FAN

2.3 FIRST TIME OPERATION

BEFORE APPLYING POWER - Set input power line switch on back panel to correspond to power source and check that the proper fuse is in place.

1. Plug into 110 or 220V, 50-60Hz.
   Set controls as follows:

POWER	on
VARIABLE PHASE GENERATOR	
FUNCTION	Sine
AMPLITUDE	Fully clockwise
OFFSET	
POS	Disengaged
INV	Disengaged
VAR	Disengaged
ATTENUATOR	
10db	Disengaged
20db	Disengaged
30db	Disengaged
PHASE LEAD	
QUADRANT	1
DEGREES	00.0
REFERENCE GENERATOR	
FUNCTION	Sine
AMPLITUDE	Fully clockwise
OFFSET	
POS	Disengaged
INV	Disengaged
VAR	Disengaged
ATTENUATOR	
10db	Disengaged
20db	Disengaged
30db	Disengaged
RANGE	1kHz
FREQUENCY MULTIPLIER 1.0	1.0
RUN	Engaged
GATE	Disengaged
HOLD	Disengaged
10:1 SYM	Disengaged
CLOCK	INT

2. Connect VAR PHASE OUTPUT to scope, observe a sine wave 20V P-P centered about ground. Terminate cable with 50Ω and observe sine wave 10V P-P.

3. Switch VARIABLE PHASE FUNCTION switch to triangle and then square, observe both waveforms are 10V P-P centered about ground.

2.3 FIRST TIME OPERATION (Continued)

4. Turn VARIABLE PHASE AMPLITUDE slowly counter clockwise, observe 20db attenuation (1V P-P) in full counter clockwise position. Return to clockwise position.

5. Depress VARIABLE PHASE 20db ATTENUATOR and observe 1V P-P waveform (-20db from 10V P-P). Release 20db ATTENUATOR and depress 10db and 30db ATTENUATOR and observe waveform of 100mv (-40db). Depress 20db and turn VARIABLE PHASE AMPLITUDE fully counter clockwise and observe 80db of attenuation (1mv). Also note low noise level. If some 60Hz or 120Hz signal appears at this low level, float the instrument by removing the gound strap from rear panel. Release all attenuator buttons.

6. Engage VARIABLE PHASE OFFSET - VAR and turn VARIABLE PHASE DC OFFSET. Observe ±5V of offset. Turn AMPLITUDE fully clockwise and note that the output is clipped when more than a small offset is applied. This is the limitation of the Power Amplifier. Release VAR and engage POS, observe waveform is shifted above ground. Engage INV and observe waveform shifts below ground. Release POS and INV.

7. Connect a cable from VAR PHASE SYNC OUT to the other channel of the scope. Observe a square wave coincident with the OUTPUT square wave. Turn VARIABLE PHASE. FUNCTION to triangle then sine and observe SYNC OUT square wave to be coincident with peaks of OUTPUT waveforms.

8. Connect REFERENCE OUTPUT to scope observe sine wave 20V P-P centered about ground. Terminate cable with 50Ω and observe a sine wave 10V P-P.

9. Switch REFERENCE FUNCTION switch to triangle and then square, observe both waveforms are 10V P-P centered about ground.

10. Turn REFERENCE AMPLITUDE slowly counter clockwise, observe 20db attenuation (1V P-P) in full counter clockwise position. Return to clockwise position.

11. Depress REFERENCE 20db ATTENUATOR and observe 1V P-P waveform (-20db from 10V P-P). Release 20db ATTENUATOR and depress 10db and 30db ATTENUATOR and observe waveform of 100mv (-40db). Depress 20db and turn REFERENCE AMPLITUDE fully counter clcokwise and observe 80db of attenuation (1mv). Also note low noise level. If some 60Hz or 120Hz signal appears at this low level float the instrument by removing ground strap from rear panel. Release all attenuator buttons.

12. Engage REFERENCE OFFSET-VAR and turn REFERENCE DC OFFSET. Observe ±5V of offset. Turn Amplitude fully clockwise and note that the output is clipped when more than a small offset is applied. This is the limitation of the Power Amplifier. Release VAR and engage POS, observe waveform is shifted above ground. Engage INV and observe waveform shifts below ground. Release POS and INV.

2.3 FIRST TIME OPERATION (Continued)

13. Connect a cable from REFERENCE SYNC OUT to the other channel of the scope. Observe a square wave coincident with the OUTPUT square wave. Turn REFERENCE FUNCTION to triangle then sine and observe SYNC OUT square wave to be coincident with peaks of output waveforms.

14. Connect VAR PHASE SYNC OUT and REFERENCE SYNC OUT to the counter. Switch RANGE through its positions and check the frequency of both generators in each position. Observe that the RANGE setting within 1% and that both generators are running at precisely the same frequency.

15. Set RANGE to 1kHz and switch the outer, detented, control on the FREQUENCY MULTIPLIER through its positions. Observe that the frequency is RANGE x MULTIPLIER at all positions. Return FREQUENCY MULTIPLIER to 1.0.

16. Set frequency to 10Hz and set FREQUENCY MULTIPLIER to .28. Finely adjust the FREQUENCY MULTIPLIER vernier control to set the period to 360.00 msec. Set counter to read period A to B, and set both inputs to trigger at zero crossing of positive slope. The counter should now read either 0.0 or 360.0. The PHASE LEAD switch is operated by depressing the pushbuttons above and below the numbers. The angle set by the PHASE LEAD control is the sum of quadrant and angle setting:

(QUADRANT -1) X 90° + DEGREES = PHASE LEAD

Switch the PHASE LEAD control to various settings. Observe that at the frequency set above, the period A to B equals the phase lead.

17. Set Range to 1kHz. Connect VARIABLE PHASE OUTPUT and REFERENCE OUTPUT to scope. Observe the phase shift at various PHASE LEAD settings. Also note that the phase lead is unaffected by the condition of the AMPLITUDE ATTENUATOR and OFFSET controls. The phase lead is maintained for any combination of waveforms except when one generator is in square and the other one is not. In this case the following conversion must be made:

REFERENCE GENERATOR in square mode	add 90°
VARIABLE PHASE GENERATOR in square mode	subtract 90°

This occurs because the square wave is coincident with the peaks of the triangle and sine waves.

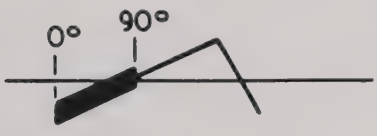
2.3 FIRST TIME OPERATION (Continued)

18. Connect a signal source to TRIG IN. The frequency of the trigger signal should be less than the generator frequency and at least 1.5V positive. Adjust the trigger level if necessary until waveforms appear on the scope. The REFERENCE GENERATOR locks out at the center of the waveform except in square; independant of any controls. The lockout level of the VARIABLE PHASE GENERATOR is controlled by the PHASE LEAD control, ie. the lock out level corresponds to the phase lead. Both generators start their cycles at the same time.

19. Apply a positive ramp or triangle to TRIG IN and engage GATE. Observe a burst on the scope. The number of cycles per burst can be controlled by adjusting the trigger level. Disengage GATE.

20. Engage RUN. Set RANGE to 1Hz and set FREQUENCY MULTIPLIER to .50. Set both generators to triangle. Engage HOLD and observe both triangles are caught and held. Repeat several times noting that the waveform can be held at any point.

21. Release RUN. Engage 10:1 SYM, set DEGREES to 00.0° and QUADRANT to 4. Observe the triggered ramp from the VAR PHASE OUTPUT. Switch QUADRANT to 2 and note the inversion of the ramp. Observe REFERENCE OUTPUT with RUN engaged. Phase lead in this mode must be interpreted differently. Because of the 10:1 symmetry, it would be meaningless to attach an actual degrees phase lead to the waveforms, but it can be useful if interpreted as pictured below:

QUADRANT SETTING	DEGREES RANGE
1	
2	
3	
4	

2.3 FIRST TIME OPERATION (Continued)

22. Switch both generators to square and observe pulses with a 9% duty cycle. Here again the phase must be interpreted differently. The entire 360° can be covered with either a positive or negative pulse.

QUADRANT SETTING	DEGREES RANGE
1	0°-180° positive pulse
2	0°-180° negative pulse
3	180°-360° negative pulse
4	180°-360° positive pulse

23. Engage RUN, set FREQUENCY MULTIPLIER to bottom of search range. Apply a positive voltage less than 5.5V to VCF INPUT. Observe frequency changes as the input voltage changes. The OUTPUT frequency will be:

$$\frac{\text{RANGE X VCF VOLTAGE}}{5}$$

Apply a 5V positive ramp to VCF INPUT and observe the OUTPUT frequency sweep through 3 decades.

24. Set FREQUENCY MULTIPLIER to 1.0 and RANGE to 1K and engage REFERENCE OFFSET - POS. Connect a 4V P-P, 1kHz square wave into EXTERNAL HOLD. Observe a hold condition when the square input is low.

25. Connect CLOCK OUT to counter and observe that the clock is always 1800 times the OUTPUT frequency except in the 50kHz mode where it is 180 times.

26. Connect REFERENCE OUTPUT and PHASE OUT to scope and observe that the phase pulse occurs as the REFERENCE OUTPUT crosses zero on the rise. The phase pulse is 100ns wide.

SECTION 3

CIRCUIT DESCRIPTION

FIGURE 6.10
BLOCK DIAGRAM 337

3.1 BLOCK DIAGRAM (Figure 6.1)

There are six power supplies in the instrument +2.75V, -2.25V, +20V, -20V, +15V and -15V. The -2.25V regulator is referenced from the +2.75 supply to insure the total voltage to drive the logic is 5.0V. The -20V regulator is referenced from the +20V supply and the +15V regulator regulates the +20V supply. The -15V regulator is referenced from the +15V supply and reregulates the -20V supply.

The clock can be obtained either externally or internally. The internal clock may be controlled in two ways with the FREQUENCY MULTIPLIER or the VCF INPUT. Either one applies a voltage to the VCF amplifier which drives the current sources. There is a positive and a negative voltage controled current source that charge and discharge a capacitor. The voltage on the capacitor is fed to the level detector which switches at voltages of OV and 2V. The square wave from the level detector is fed back to the negative current source switching it in or out to produce a triangle on the capacitor. The square wave from the level Detector or the external clock fed to the frequency divider. The amount of division is set by the RANGE switch. The clock is then fed to the clock run circuitry which recieves signal from several other parts of the instrument to determine if the clock is fed to the generators. The trigger input signal and trigger level control are compared and when the difference is positive the comparator switches. This signal will start the clock. If gate is engaged, the clock will run until the trigger comparator switches again. MANUAL pushbutton will also start the clock. The RUN pushbutton overides the end cycle pulse thus keeping the clock running. The HOLD pushbutton and the EXTERNAL HOLD signal will overide all other controls and stop the clock.

The reference generator produces a triangle digitally. A three decade counter counts the incoming clock pulses. When the count reaches 899, a pulse is generated and fed to the up/down switch which switches on the next clock pulse. This one count delay acts as a look ahead to insure that the counter always counts properly. The counters now start counting down and when it reaches 1 the same procedure is repeated. The output of the counter is fed to a D/A converter which converts this up/down counting to a triangle. At a count of 451, counting down, a pulse is generated which is fed to the clock control logic as an end cycle pulse. It is also fed to the load logic. In a RUN of GATE mode this pulse will not stop the clock but will be senced in the variable phase counter. In a trigger mode, the pulse will stop the clock and load the generators. The load count in the reference generator is set at 450, to produce a lockout level at ground. For the 50 KHz range the first decade is disabled so the counter counts to 900 in 90 clock pulses. The 10:1 symmetry switch will cause the first decade to be disabled only when the counters are counting up thus producing a 10:1 symmetry waveform. This is done on the up count because the triangle is inverted three times so, at the output, this is the reset. The sine wave is generated from the triangle by the sine shaper which is composed of four diode bridges. The output of the up/down switch is used as the SYNC OUT and, after conditioning in the square switch, forms the square wave. A waveform is selected and fed to the preamplifier and the power amplifier. Amplitude and DC offset controls are connected and here step attenuator follows the P.A. output and the final conditioning is a filter on the output jack that removes noise generated by the clock and D/A converter.

3.1 BLOCK DIAGRAM (Figure 6.1) (Continued)

The Variable Phase Generator operated in about the same manner as the reference generator. No end cycle pulse is generated because there is no need for two, being that both generators always run at the same frequency. The pulse recieved from the load logic at the end of each cycle momentarily loads the counter to a preset count set by the phase control. The counter should be at this count already so there is no discontinuity in the waveform. This pulse is there to insure that the counters stay at the preset phase. The output of the phase switch is BCD and is converted to binary so that arithmatic operations can be performed readily. In the first and fourth quadrants the number is first complimented. The quadrant also sets a number to be added. The output of the adder is then converted back to BCD and fed to the counter. Along with being loaded to this number of the end of each cycle, this is also the lockout count. The remainder of the generator is the same as the Reference generator.

3.2 POWER SUPPLY (Figure 6.2)

The power line voltage is fed to the instrument through Plug P100 to the protective fuse F100. The line switch S101 supplies line voltage to the operating voltage selector S102. S102 appli the voltage to the transformer T100 in either a series or parallel arrangement depending on the line voltage available. The transformer is used to step down the voltages to lower values for application to the rectifier filter combinations in the instrument. Diodes D100, D101, D102 and D103 in combination with capacitors C100 and C101 supply an unregulated voltage of approximately +7V to supply the integrated circuit regulator Q110. Q110 is a complete powe supply inside an integrated circuit package. It contains its own reference, voltage supply a error amplifier. Q110 is an external series pass transistor, with Q103 driving it, used to enhan the current carrying capabilities of Q110. R105 is a current sensing resistor used to supply current limiting voltages to the integrated circuit Q110. Resistive divider R110, R111 and R112 is used to provide the necessary feedback voltage to the error amplifier inside Q110. R111 provides for a small adjustment in the value of the output voltage. Diode D110 prevents an external application of negative voltage to any of the circuitry on the +2.75V logic power supply lines.

Operational amplifier Q115 is used as an inverting amplifier with a gain of 1 to provide a -2.25V power supply that tracks very accurately the +2.75V power supply. The output of the series pass transistor, Q125 is applied to the -2.25V line through current sensing resistor R130. Transistor Q130 is used to provide a feedback signal when current limit is reached. This feedback signal is applied to the input of the operational amplifier and reduces its output in the event of a current limit. Feedback necessary for closed operation is through R116 adjustment R118 and R117 to the +2.25V supply. Adjustment R118 is used to provide the small range of adjustment in the output voltage of the -2.25V supply. Diode D111 is used to preven damage in the event of an application of positive voltage to the -2.25 line.

3.2 POWER SUPPLY (Continued)

With all of the TTL logic and logic interface circuitry, etc. connected to the +2.75V and -2.25V power supplys, an overvoltage would be somewhat catastrophic; therefore, a completely passive "Crowbar" circuit has been installed. Any overvoltage on the power supply lines in excess of 10% will cause Q140 a silicon control rectifier, to conduct and remain conducting until the overvoltage has been corrected. The power switch must be turned off and then on again to restore operation. SCR Q140 receives its gate current drive from Transistor Q135. Transistor Q135 is operated as a saturated switch. It gets its base drive from the temperature compensating resistor network R139, R135, R136, R137 and R138.

Full wave diode bridge D104 along with filter capacitors C102 and C103 provides approximately ±30V for the regulators that regulate to +20V and -20V. Integrated circuit Q150 is a power supply unit that contains its own reference error amplifier, etc. Transistor Q145 is used to enhance the current carrying capability of the integrated circuit. Resistor R145 provides the current sensing so that the integrated circuit can be used to provide current limiting. Feedback voltage for the error amplifier in the integrated circuit can be used to provide a small amount of voltage adjustment for the +20V supply. Diode D150 provides protection against accidental application of negative voltages to the +20V power supply line. The +20V supply is used as a reference for the discreet component regulator that generates the -20V. Divider R172, R173, and R174 applies this reference to the differential amplifier made up of transistors Q165 and Q170. The base of transistor Q165 is held at +3V by resistors R165 and R167. The output of the differential pair (which appears at the collector of Q165) is applied to the base of transistor Q175 through resistor R166.

Capacitor C175 and resistor R176 are phase compensating networks for the regulator. The output of transistor Q175 is applied to resistor R177 which in turn is connected to the base of the series pass transistor Q180. The emitter of Q180 supplies the necessary output current through current sensing resistor R181 to the power supply output. Transistor Q185 is used to provide a feedback signal to the differential amplifier Q170 through diode D185. This turns power supply voltage off in the event of a current limit signal which is developed across R181. Feedback necessary for power supply operation is through resistor R174 which maintain the reference to Q170 at +3V when both the power supplies are equal and opposite. Adjustment R173 provides for small amount of adjustment in the output voltage of the -20V from regulator Q150 is applied to integrated circuit Q160 and is re-regulated. Q160 is a complete power supply in one integrated circuit; that is, it has its own reference, error amplifier, etc. Transistor Q155 is a current sensing resistor used to provide current limit operation of the integrated circuit. Feedback necessary for closed loop operation is through resistive divider made up of R161, R162 and R163. Adjustment R162 is used to provide a small amount of variation in the value of the supply voltage obtained at +15V power supply. Diode D160 is used to prevent damage in the event of application of negative voltage to the +15V power supply line. Operational amplifier Q190 is used as an inverting amplifier with a gain of 1 to provide a -15V power supply that tracks very accurately the +15V power supply. Diode D193 is used to shift the level of the operational amplifier to a higher voltage for operation of the Darlington circuit made up of transistors Q195 and Q197. The output of the series pass transistor Q197 is applied to the -15V line through current sensing resistor R197. Transistor Q199 is used to provide a feedback signal when current limit is reached. This feedback signal is applied to the input of the operational amplifier and reduces its output in the event of a current limit.

3.2 POWER SUPPLY (Continued)

Feedback necessary for closed loop operation is through R190 adjustment R191 and R192 to the +15V supply. Adjustment R191 is used to provide the small range of adjustment in the output voltage of the -15V supply. Diode D191 is used to prevent damage in the event of an application of positive voltage to the -15V line.

3.3 FREQUENCY CONTROL CIRCUITRY (Figure 6.3)

The inputs to the VCF amplifier Q200 determines the frequency. The MULTIPLIER switch is wired as a Kelvin-Varley divider which also has a search position which allows the vernier potentiometer to sweep the entire range of the frequency control circuit, that is 1000:1. An externally applied VCF input is the other frequency control input to the VCF amplifier. There is a third input from the Search Range potentiometer, R228 which forms part of the voltage divider R227, R228 and R229. This input prevents the frequency from going to zero and is adjusted for a lowest frequency of 1/1000 of the frequency range. The VCF BAL potentiometer, R225, adjusts the internal D.C. Offset at Q200. Diodes D220 and D221 limit the voltage input.

3.4 CLOCK GENERATOR (Figure 6.4)

The level shifiting amplifiers tied to the output of the VCF amplifier are voltage controlled current sources which provide equal and opposite voltage to drive the current sources. Q230 and Q235 form the positive level shifter. Q230 is driven from the inverting input, Q235 forms a buffer for the output of Q230 resulting in a high output impedance. Pos Drive Bal potentiometer, R232, allows for balancing the internal D.C. offset in Q230. The negative level shifter, Q250 and Q255 operates in a similar manner, but Q250 is driven from the non-inverting input, with R250 being used to balance D.C. offset.

The positive and negative current sources are driven from the level shifters. Q240 and Q245 form the positive current source. Operational amplifier Q240 is driven from the non-inverting input and the emitter voltage at the emitter follower, Q245 is fed back to the inverting input of Q240. The output current of the current source is controlled by the voltage at the emitter of Q245, which is the same as the input voltage at Q240. The input voltage varies from 10-15 volts. Positive Current Balance R241 provides for balancing the offset in Q240. The negative current source, Q260 and Q265 operates in a similar manner. The positive current source is connected directly to the timing capacitance C245, C246 and C247. The negative current source is connected to the timing capacitance through the diode switch D265 and D266, which is controlled by the level detector. When switched in, the negative current source pulls enough current to cancel the positive current source and drain charge from the timing capacitance. The resulting triangle is fed to the buffer, Q270 and Q275. Field effect transistor, Q270A provides a high input impedance for the triangle. Q275A then provides a low output impedance to the level detector. Q270A and Q275A have matched counterpart. Q270B and Q275B which set the offset in the buffer at 0V by insuring that the base emitter drop of Q275A equals the source-gate drop in Q270A. C277, C278, R282 and R277 form a voltage divider and high frequency lead network, which compensates for the high frequency response of the level detector. Q295 forms a constant current source providing operating current for the matched differential pair Q280. Q280 compares the triangle voltage to a

3.4 CLOCK GENERATOR (Figure 6.4) Continued

reference voltage across R282. This square wave drives the diode switch D282 and D283 to change the reference voltage, thus creating positive feedback, necessary for level detector operation. The square wave also drives the negative current source diode switch thus forming a closed loop around the current source and level detector.

3.5 CLOCK DIVIDER CIRCUITRY (Figure 6.5)

Q310A acts as a buffer between the level detector and Q300. Q300 is a decade counter wired to divide by 5. Its output is fed to the chain of counters Q320 through Q350 for further division. The output of the RANGE switch is fed to Q315A, B, and C and to Q355. Q355 is a multiplexer, which selects an input from the counters to put at its output, depending on the binary input from the RANGE switch. At the 5KHz setting the clock bypasses Q300 through Q310B and remains undivided. At 50KHz a signal is generated by Q310D which is used to disable the first decade in the generators. The output of Q355 at pin 6 is the clock to drive the generators. Q360B and C are used in another unit.

3.6 CLOCK CONTROL CIRCUITRY

Q370A and Q370B form an R-S flip-flop which determines whether the clock will run. A low input at Q370A starts the clock and a low input to Q370B stops the clock. RUN holds Q370A pin 4 low so that the clock runs irregardless of what happens at Q370B. The signal applied to Q370A pin 4 from RUN comes from the HOLD circuitry so that HOLD will override RUN. HOLD is connected to an R-S flip-flop Q365A and Q365B which prevents switch noise from falsely triggering the circuit. When HOLD is depressed a pulse is sent from Q365A to Q370B through C369 to stop the clock. The signal from Q365B overrides RUN, when HOLD is released a pulse is fed to Q370A through C366 to start the clock. In the trigger mode no inputs to Q370A are held low so the end cycle pulse at Q370B pin 13 will stop the clock. MAN is connected to Q370A through R-S flip-flop Q497A and Q497B which removes switch noise from the signal. GATE bypasses C497 so that the clock will run as long as MAN in hold in and the end of the next cycle. The external trigger signal is fed to Q390, a differential comparator. Summed into this signal is a negative DC level from TRIG LEVEL. When the sum is positive and greater than the voltage at the other input of Q390 the comparator switches low. A feedback loop back to pin 2 creates a small amount of hysterisis to prevent a noisy signal from mistriggering the comparator, thus the trigger input signal must drop approximately .5V below the trigger level before the comparator switches again. Q305D is fed to Q375A and B. At the beginning of the clock pulse following this signal going high a short pulse is allowed through Q375B which triggers the R-S flip-flop Q375A and Q378C which in turn allows the clock through Q375D to run the generators. This is done to insure that the first clock pulse is long enough to perform all necessary switching in the generators. EXTERNAL HOLD is connected to Q375A and Q375B such that a negative pulse will reset the flip-flop and prevent a pulse form Q375B from setting the flip-flop again until the EXTERNAL HOLD signal goes high again. The output of Q370A and the end cycle pulse are also fed to the R-S flip-flop Q400A and Q400B. In the trigger mode the output of Q370A goes high at the end of a cycle which allows the flip-flop to switch. The output of Q400B is then fed to the load circuitry shown on schematic 10.

3.7 VARIABLE PHASE COUNTER

The counting is done by 3 programmable up/down BCD counters connected to synchroniously count through three decades. The clock is connected to pin 14 of the three counters Q410, Q445 and Q465. Pin 4 is the enable input, it is tied low on the first counter. When counting up, pin 12 of Q410 goies high at the count of 9 and enables the second counter Q445 for one clock pulse. When both Q410 and Q445 reach counts of 9, Q465 is enabled for one count thus we are counting through three decades of BCD with Q410 counting the units place Q445 counting the tens place and Q465 counting the hundreds place. Q470B senses when Q465 has reached a count of 8 and this plus the outputs from Q410 and Q445 are fed to Q480B. Thus at a count of 899 a pulse is generated at Q480B which is fed to JK flip-flop Q485A the pulse is inverted and clocks Q480A which invents the outputs. At the beginning of the next clock pulse the outputs Q485B are switched and sent back to the counters up/down inputs to switch the direction of counting. This look ahead of sensing the peak count one count early insures that the counter will switch direction at the count of 900 at higher frequencies, by overcoming the propogation delay in the logic. When counting down, the outputs at pin 12 of the counters goes high at a count of 0 thus reversing the enabling process between the counters. Q420A senses a count of 1 in the first counter which is fed to Q480A along with the pin 12 outputs of the other two counters. Thus a pulse is generated at a count of 001 by Q480 which, by the same process as described above switches the direction of counting. The end result here is that the counters are continuiously counting up to 900 and back to 000 as long as the clock runs.

In the 50KHz range several things are done to the system. The input to Q493B goes low at this range. This sets the load input, pin 11, to Q410 low which loads the counter to the programmed inputs at pins 15, 1, 10 and 9. The output of Q493B is inverted by Q405B and fed to Q435C and Q425 A, B, C and D. This sets the count direction to down and the programmed inputs to 0. All this has the effect of diabling the second counter so that there are 90 counts instead of 900. The count sensing logic also has to be changed in the 50KHz range Thus Q420A is set high and the output of Q470A is allowed through Q460D instead of the output of Q445. Thus a count of 1 is sensed instead of a 0 and the look ahead still works. An exclusive or function is performed on the output of Q485B and the programmed count direction at TP490 (see Phase Lead Circuitry) by Q490 and is fed to Q405A. Thus when the 10:1 SYM button is engaged all of the functions described in the previous paragraph are done, but only when the counters are counting up. Thus there are 900 counts down and 90 counts up. At the end of each cycle of the reference generator a pulse is generated which is fed to pins 11 of the three counters to load them all momentarily to the programmed count. The up/down switch Q485A is also cleared or preset depending on the quadrant. In the trigger mode this pulse stays low until the next trigger signal starts the clock.

The out of the up/down switch, Q485B is fed to the buffer Q600 and Q605 to form the SYNC OUT signal and the square wave to be conditioned later. The BCD outputs of the counters are fed to the D/A converter and the programmed inputs are set by the phase lead circuitry.

3.8 PHASE LEAD CIRCUITRY (Figure 6.9.0)

The four phase lead switch BCD outputs which are fed to arithmatic circuitry that performs the following functions:

QUADRANT	FUNCTION
1	$\frac{900 - S \times 10}{2}$
2	$\frac{S \times 10}{2}$
3	$\frac{900 + S \times 10}{2}$
4	$\frac{1800 - S \times 10}{2}$

Where S is the phase switch output.
In binary the function would read as:

QUADRANT	FUNCTION
1	$\frac{\overline{(S \times 1010)} + 1110000101}{2}$
2	$\frac{S \times 1010}{2}$
3	$\frac{S \times 1010 + 1110000100}{2}$
4	$\frac{\overline{S \times 1010} + 11100001001}{2}$

The switch outputs are first inverted to change the number to BCD from BCD compliment. In the 50KHz range the first four inputs are disabled because the first counter is disabled. Multipling the switch reading by 10 is in effect done here by shifting decimal point. This 11 bit BCD number is now converted to binary by Q925 through Q950. Figure 3.8.0 a trueth table for these devices. The resultant binary number is fed to a series of exclusive or gates (Q955, Q960, Q965) which compliment the number in the first and fourth quadrant as determined by the QUADRANT switch logic Q915 and Q920.

3.8 PHASE LEAD CIRCUITRY (Continued)

The QUADRANT switch also sets the number to be added as shown in the above equations. The addition is done by Q1000, Q100S and Q1010 which are connected to form a 12 bit adder. The output of the adders is then converted back to BCD by Q1015 through Q1040. The least significant bit is ignored to impliment the divide by two. This completes the calculation and the result is fed to the counters of the variable phase generator.

TRUTH TABLE FOR SN74184N AND SN74185N (Figure 3.8.0)

INPUTS					SN74184N OUTPUTS					SN74185N OUTPUTS					
14	13	12	11	10	5	4	3	2	1	6	5	4	3	2	1
L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
L	L	L	L	H	L	L	L	L	H	L	L	L	L	L	H
L	L	L	H	L	L	L	L	H	L	L	L	L	L	H	L
L	L	L	H	H	L	L	L	H	H	L	L	L	L	H	H
L	L	H	L	L	L	L	H	L	L	L	L	L	H	L	L
L	L	H	L	H						L	L	H	L	L	L
L	L	H	H	L						L	L	H	L	L	H
L	L	H	H	H						L	L	H	L	H	L
L	H	L	L	L	L	L	H	L	H	L	L	H	L	H	H
L	H	L	L	H	L	L	H	H	L	L	L	H	H	L	L
L	H	L	H	L	L	L	H	H	H	L	H	L	L	L	L
L	H	L	H	H	L	H	L	L	L	L	H	L	L	L	H
L	H	H	L	L	L	H	L	L	H	L	H	L	L	H	L
L	H	H	L	H						L	H	L	L	H	H
L	H	H	H	L						L	H	L	H	L	L
L	H	H	H	H						L	H	H	L	L	L
H	L	L	L	L	L	H	L	H	L	L	H	H	L	L	H
H	L	L	L	H	L	H	L	H	H	L	H	H	L	H	L
H	L	L	H	L	L	H	H	L	L	L	H	H	L	H	H
H	L	L	H	H	L	H	H	L	H	L	H	H	H	L	L
H	L	H	L	L	L	H	H	H	L	H	L	L	L	L	L
H	L	H	L	H						H	L	L	L	L	H
H	L	H	H	L						H	L	L	L	H	L
H	L	H	H	H						H	L	L	L	H	H
H	H	L	L	L	L	H	H	H	H	H	L	L	H	L	L
H	H	L	L	H	H	L	L	L	L	H	L	H	L	L	L
H	H	L	H	L	H	L	L	L	H	H	L	H	L	L	H
H	H	L	H	H	H	L	L	H	L	H	L	H	L	H	L
H	H	H	L	L	H	L	L	H	H	H	L	H	L	H	H
H	H	H	L	H						H	L	H	H	L	L
H	H	H	H	L						H	H	L	L	L	L
H	H	H	H	H						H	H	L	L	L	H

3.9 DIGITAL TO ANALOG CONVERTOR (Figure 6.8)

The BCD output of the three counters are sent to the D/A converter. The least significant decade is converted by the diode switches D500 to D507 and their associated resistive current sources, R501 through R504, and matched summing resistors, R500. The first bit of the second decade also has a passive current source but the remaining bits have active, constant current sources formed by an operational amplifier and a transistor with feedback from the emitter to the inverting input of the operational amplifier. Each active current source is adjustable over a small range and the output currents of the first and second decades are adjustable with R510 and R548.

The three outputs are summed at TP501, the input to an operational amplifier. The summing resistors R549 and R510 set the relative weighting of each decade. The operational amplifier has two signal paths. One signal path covers frequencies from D.C. to approximately 100KHz and the other signal path processes frequency above 100KHz. The input circuitry for the low frequency path is a differential pair consisting of Q625, a matched pair of FET's. Resistive divider made up of R630, R 631 and R632 is used to compensate for the differences in the gate source drops of these input resistors. The output of this differential pair and their drain load resistors R626 and R627 are applied to the differential pair Q635 and Q640. Single ended output appearing at the collector of Q640 of this differential pair is applied to a differential mixer made up of Q645 and Q650. This differential mixer mixes the low frequency signal path and the high frequency signal path. The input circuitry for the high frequency signal path flows through FET Q670 through capacitor C670 to the other input of the differential mixer Q650. The collector signal Q645 is fed to inverter transistor Q655 so that a complimentary signal of the same phase is available as the output of collector of Q650 for processing in the complimentary emitter follower buffer consisting of Q660 and Q665. Diodes D650 and D655 along with resistor R656 provide the quiescent bias voltage necessary for operation of the complimentary buffer Q660 and Q665. Diodes D651 and D656 provide short circuit protection in the event that the output of this amplifier is accidentally short circuited. The feedback around the amplifier is from R662 and C662. The relatively large value of C662 acts to integrate out noise that is associated with switching transients from the D/A converter. R623 and R622 at the summing input provide a D.C. input which shifts the triangle to be symmetrical about ground. The output of the amplifier is a triangle. It is fed to the function switch.

3.10 WAVEFORM SHAPING AND OUTPUT CIRCUITRY (Figure 6.9)

The sine shaper is a series of diode bridges which are arranged so that they provide break points along the triangular waveform creating a sinusodial function of very low distortion with an output of the proper amplitude necessary for conditioning in the amplifier circuitry. As the input voltage is raised to any one of these diode bridges, the output current from that same bridge begins to raise until it reaches the maximum value of current supplied by the resistor - potentiometer combination and then it becomes a constant current source. Each bridge is turned off at a successively higher level. The break points are chosen so that the triangle input is converted to a sine wave.

3.10 WAVEFORM SHAPING AND OUTPUT CIRCUITRY (Figure 6.9) (Continued)

The square from the sync out buffer is used to switch the diode switch, D690 and D691, with adjustable current sources to produce the square wave to be used at the output. The function switch sends the selected waveform to the preamplifie.. This amplifier operates the same as the triangle amplifier except that the input differential pair are matched bipolar transistors instead of FET's. At the input there are D.C. offset adjusts R697 and R698 for the sine and triangle which are switched in or out by the function switch. The fixed D.C. offsets are also implemented here by R765 and R766. The fixed D.C. offset switches also cut the gain of the amplifier in half by switching a resistor, R753, into the feedback loop. The output of the preamplifier tries directly into the power amplifier which is of the same type as the preamplifier, except there is another emitter follower stage to provide a lower output impedance. The AMPLITUDE and VAR D.C. Offset controls, R760 and R763, are at the input and there is a potentiometer in the feedback to adjust the output voltage. The output passes through a relay which is tied to the logic power supplies for protection. If the crowbar should trip the relay prevents the output from jumping to +15V The output passes then through the attenuator circuit. The attenuator is a series of T pad attenuators that are switched in or out by the pushbuttons. The attenuators are arranged such that the 50Ω transmission line impedance is maintained at the output. Finally there is a shielded filter at the output to insure that the clock noise is kept at a low level.

3.11 REFERENCE GENERATOR COUNTER (Figure 6.11)

Operation of this counter is similar to the VARIABLE PHASE GENERATOR counter. The programmed inputs are preset to 450 and the clear and preset of the up/down switch Q1160 are set so that the counters always start counting down at 450. There is additional circuitry to generate the end cycle pulse. Q1125A senses a count of 1, Q135B senses a count of 5 and Q1150 senses a count of 4. All these are fed to Q1170B when senses a count of 451, one count before end of cycle. This is then fed to Q1155 along with an inverted clock and the output at the up/down switch so that for the second half of the count of 451 counting down a pulse is generated to set the RS flip-flop Q1172A and B. This sets the input to Q1172C high. The other input is tied to the clock, so at the beginning of the next clock pulse Q1172C switches. Approximately 100nsec later the flip-flop resets because the counters are at a different count and Q1170B has switched. In a RUN or GATE mode pin 2 of Q1165A is high and the pulse is allowed through to momentarily load the VARIABLE PHASE GENERATOR counter. In the trigger mode the pulse is fed to the RS flip-flop in the clock control circuitry (See Sec. 3-6) and stopping the clock. A signal is sent back to Q1165A which hold it high and loads both counters. Both the clock and the end cycle signal are sent to buffers Q1164, Q171 and Q1185, Q1190.

3.12 REFERENCE GENERATOR D/A CONVERTER (Figure 6.12)

This circuitry is the same as the VARIABLE PHASE D/A converter. (See Se. 3.2)

3.13 REFERENCE GENERATOR WAVEFORM SHAPING AND OUTPUT CIRCUITRY (Figure 6.13)

This circuitry is the same as the VARIABLE PHASE OUTPUT CIRCUITRY (See Sec. 3.9)

SECTION 4

CALIBRATION PROCEDURE

4.1 CALIBRATION PROCEDURE (Figure 4.1 and 4.2)

1. EQUIPMENT REQUIRED

This unit must be on for one hour with covers in place and the outputs terminated into 50Ω before calibration.

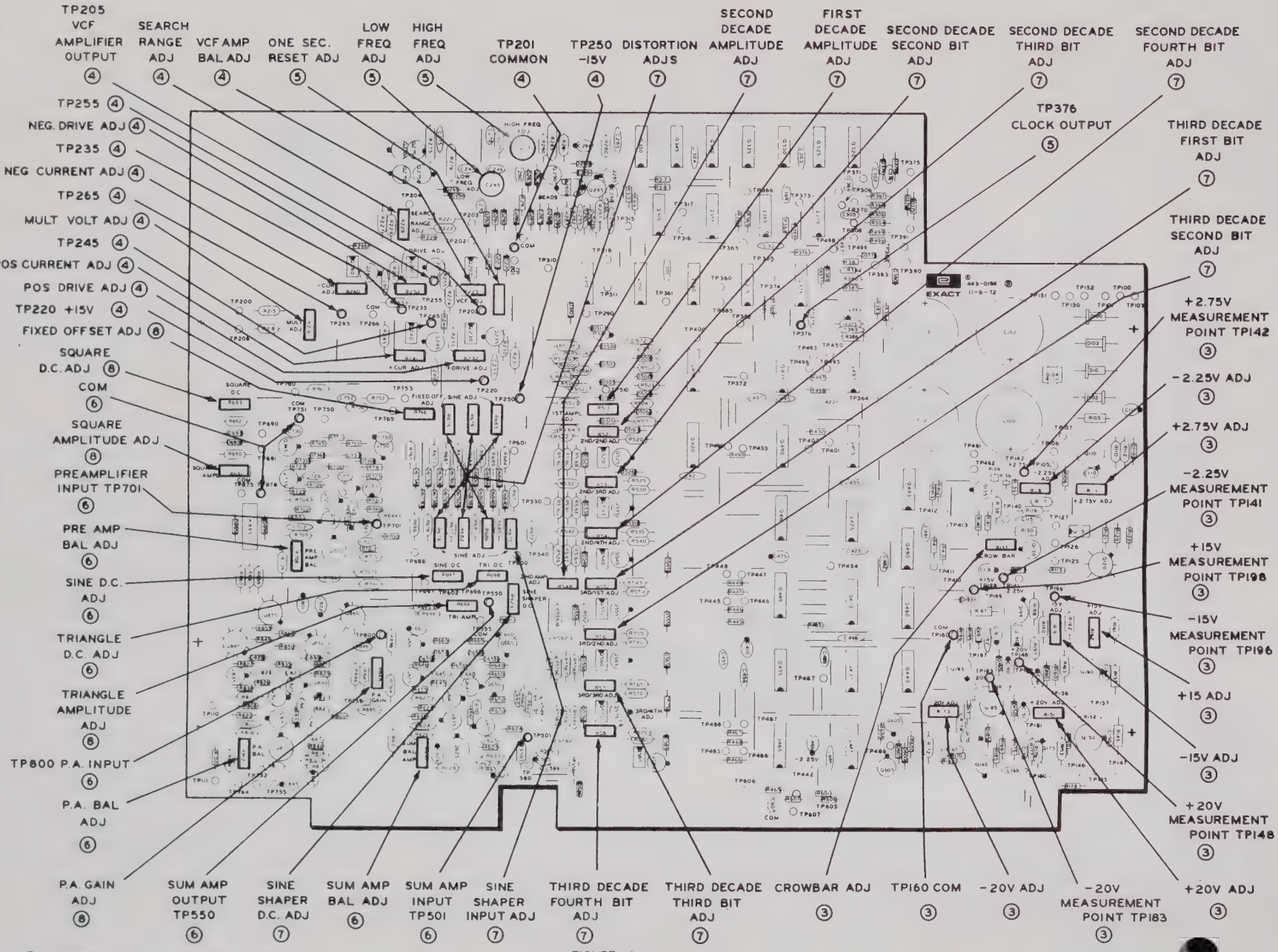
The following equipment or suitable equivalents of known accuracy are required for complete calibration.

Oscilloscope
Tektronix 544 with W and 1A1 plug-ins
Counter-Timer 50KHz - .01Hz
DANA 8010B
Digital Voltmeter .01% accuracy with 1000 megohm input impedance, floating inputs
DANA 4300
Harmonic Distortion Analyzer .1% distortion
Hewlett Packard 333

4.1 CALIBRATION PROCEDURE (Figure 4.1 and 4.2) Continued

2. INITIAL CONTROL SETTINGS

POWER SWITCH	ON
RANGE	1KHz
FREQUENCY MULTIPLIER	0.1
RUN	ENGAGED
GATE	DISENGAGED
HOLD	DISENGAGED
10:1 SYM	DISENGAGED
VARIABLE PHASE GENERATOR	
FUNCTION	SINE
AMPLITUDE	FULLY CLOCKWISE
OFFSET	
POS	DISENGAGED
INV	DISENGAGED
VAR	DISENGAGED
ATTENUATOR	
10db	DISENGAGED
20db	DISENGAGED
30db	DISENGAGED
REFERENCE GENERATOR	
FUNCTION	SINE
AMPLITUDE	FULLY CLOCKWISE
OFFSET	
POS	DISENGAGE
INV	DISENGAGE
VAR	DISENGAGE
ATTENTUATOR	
10db	DISENGAGE
20db	DISENGAGE
30db	DISENGAGE


TP205 VCF AMPLIFIER OUTPUT ④
SEARCH RANGE ADJ ④
VCF AMP BAL ADJ ④
ONE SEC. RESET ADJ ⑤
LOW FREQ ADJ ⑤
HIGH FREQ ADJ ⑤
TP201 COMMON ④
TP250 -15V ④
DISTORTION ADJS ⑦
SECOND DECADE AMPLITUDE ADJ ⑦
FIRST DECADE AMPLITUDE ADJ ⑦
SECOND DECADE SECOND BIT ADJ ⑦
SECOND DECADE THIRD BIT ADJ ⑦
SECOND DECADE FOURTH BIT ADJ ⑦
TP255 ④
NEG. DRIVE ADJ ④
TP235 ④
NEG CURRENT ADJ ④
TP265 ④
MULT VOLT ADJ ④
TP245 ④
POS CURRENT ADJ ④
POS DRIVE ADJ ④
TP220 +15V ④
FIXED OFFSET ADJ ⑧
SQUARE D.C. ADJ ⑧
COM ⑥
SQUARE AMPLITUDE ADJ ⑧
PREAMPLIFIER INPUT TP701 ⑥
PRE AMP BAL ADJ ⑥
SINE D.C. ADJ ⑥
TRIANGLE D.C. ADJ ⑥
TRIANGLE AMPLITUDE ADJ ⑧
TP800 P.A. INPUT ⑥
P.A. BAL ADJ ⑥
P.A. GAIN ADJ ⑧
SUM AMP OUTPUT TP550 ⑥
SINE SHAPER D.C. ADJ ⑦
SUM AMP BAL ADJ ⑥
SUM AMP INPUT TP501 ⑥
SINE SHAPER INPUT ADJ ⑦
THIRD DECADE FOURTH BIT ADJ ⑦
THIRD DECADE THIRD BIT ADJ ⑦
CROWBAR ADJ ③
TP160 COM ③
-20V ADJ ③
-20V MEASUREMENT POINT TP183 ③
+20V ADJ ③
TP376 CLOCK OUTPUT ⑤
THIRD DECADE FIRST BIT ADJ ⑦
THIRD DECADE SECOND BIT ADJ ⑦
+2.75V MEASUREMENT POINT TP142 ③
-2.25V ADJ ③
+2.75V ADJ ③
-2.25V MEASUREMENT POINT TP141 ③
+15V MEASUREMENT POINT TP198 ③
-15V MEASUREMENT POINT TP196 ③
+15 ADJ ③
-15V ADJ ③
+20V MEASUREMENT POINT TP148 ③
EXACT

○ INDICATES CALIBATION SEQUENCE

FIGURE 4.1
ADJUSTMENT LOCATION DETAIL

4.1 CALIBRATION PROCEDURE (Continued)

ALL BELOW ADJUSTMENTS ON BOTTOM BOARD (Figure 4.1.0)

3. USING DVM (with tp160 as com)

A. Probe to +20V measurement point (tp148) and adjust the +20V Adjust for +20 ± .01V.

B. Probe to -20V measurement point (tp183) and adjust the -20V Adjust for -20V ± .01V.

C. Probe to +15V measurement point (tp198) and adjust the +15V Adjust for +15V ± .01V.

D. Probe to -15V measurement point (tp196) and adjust the -15V Adjust for -15V ± .01V.

E. Float the DVM. High Probe to +2.75V measurement point (tp142), low probe to -2.25V measurement point (tp141). Turn the Crowbar Adjust fully clockwise. Adjust the +2.75V and -2.25V Adjust for a reading of 5.50V ± 0.05V. (Note: Do not allow the voltage to greatly exceed 5.50V to avoid damage to the ICs.) Adjust the Crowbar Adjust until the voltage jumps to 0.7V. Turn back the +2.75V and -2.25V Adjusts and turn the power off and then on again to deactivate the Crowbar. Adjust the voltage towards 5.50V again and check that the Crowbar trips at 5.50V ± .05V. Readjust if necessary.

F. Probe to +2.75V measurement point (tp142) (with tp160 as com) and adjust the +2.75V Adjust for +2.75 ± .01V.

G. Probe to -2.25V measurement point (tp141) and adjust the -2.25V Adjust for -2.25V ± .01V.

4. USING DVM AND SCOPE (with tp201 as com)

A. Set Frequency Multiplier to .55. Probe to Multiplier Voltage measurement point (tp200) and adjust the Multiplier Voltage Adjust for 5.50V ± .01V.

B. Set MULTIPLIER to 5.0and RANGE to 50KHz. Adjust VCF Amplifier Balance for minimum change in frequency when VCF input is grounded.

C. Set Frequency Multiplier to bottom of search. Probe to VCF amplifier output (tp205) and adjust SEARCH RANGE ADJUST for -5mV ± .1mV.

4.1 CALIBRATION PROCEDURE (Continued)

D. Float DVM. High probe to Positive Current Drive measurement point (tp235), low probe to +15V (tp220) and adjust Positive Current Drive Balance Adjust for -0.005V ± .1mV.

E. Float DVM. High probe to Positive Current Source measurement point (tp245), low probe to +15V (tp220) and adjust Positive Current Source Balance Adjust for -0.005V ± 1mV.

F. Float DVM. High probe to Negative Current Drive measurement point (tp255), low probe to -15V (tp250) and adjust Negative Current Drive Balance for +0.005V ± .1mV.

G. Float DVM. High probe to Negative Current Source measurement point (tp265) low probe to -15V (tp250) and adjust Negative Current Source Balance to +.005V ± .1mV.

5. USING TIMER-COUNTER

A. Set RANGE to 1KHz and MULTIPLIER to .10. Connect counter to either SYNC OUT and Adjust Low Frequency Adjust for 100Hz ± 1Hz.

B. Set MULTIPLIER to 1.00. Adjust High Frequency Adjust for 1KHz ± 10Hz.

C. Set MULTIPLIER to bottom of search and adjust Search Range Adjust to 1Hz.

D. Repeat steps A and B and C several times because of interaction.

E. Check MULTIPLIER tracking.

F. Set MULTIPLIER to 1.00. Probe to clock output (tp376). Check RANGE tracking. The clock rate should be 1800 times the RANGE setting except on the 50KHz range where it should be 180 times.

6. USING SCOPE

A. Connect SCOPE to VARIABLE PHASE OUTPUT. Set Function to triangle and set Sine DC Adjust and Tri DC Adjust to midrange.

B. Connect a clip lead from the Power Amplifier input to ground (tp759 and tp878). Adjust P.A. Balance for 0.000V ± .001V.

C. Move the clip lead to the Preamplifier input and ground (tp701 and tp751). Adjust Preamp Bal for 0.000V ± .010V.

D. Move the clip lead to the summing amplifier input and output (tp501 and tp550). Adjust sum Amp Bal for 0.000V ± .010V. Remove clip lead.

7. USING HARMONIC DISTORTION ANALYZER AND OSCILLOSCOPE

A. Set RANGE to 100Hz, MULTIPLIER to 1.00, and FUNCTION to sine. Connect the distortion analyzer to Variable Phase OUTPUT and connect the scope to distortion analyzer output (distortion products). The scope trace should be as in figure 4.7.1. (Some noise is to be expected.)

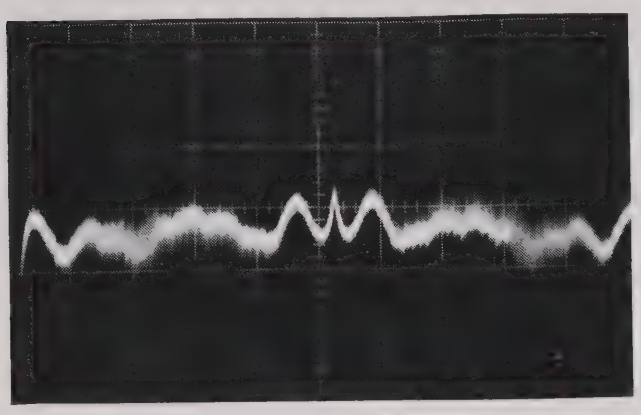


Figure 4.7.1

B. Turn Second Decade Amplitude Adjust. Obtain a scope trace as in figure 4.7.2.

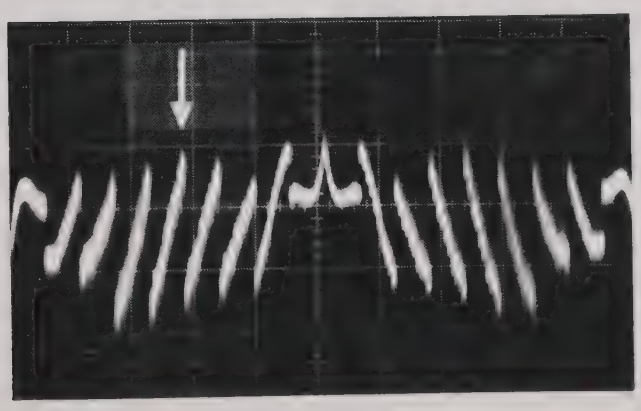


Figure 4.7.2

7. USING HARMONIC DISTORTION ANALYZER AND OSCILLOSCOPE Cont'd

Expand the portion that the arrow points to on figure 4.7.2 and adjust First Decade Amplitude and Second Decade Bit Adjusts to obtain a trace as in figure 4.7.3.

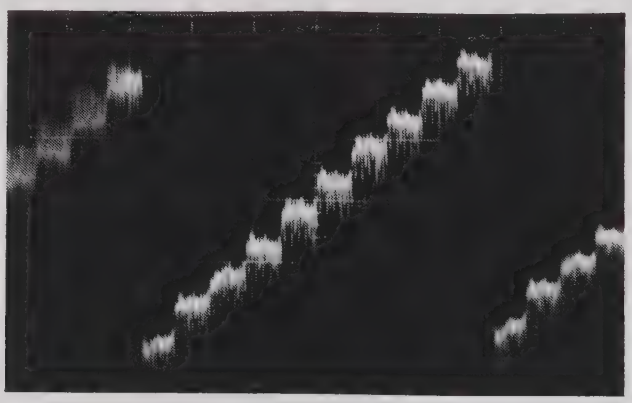


Figure 4.7.3

Now readjust the Second Decade Amplitude Adjust to produce a smooth curve.

C. Reset the scope to again see a trace as in figure 4.7.1. Adjust the Third Decade Bit Adjusts to product the smoothest possible line.

D. Now adjust the Sine Shaper Input, D.C. and Distortion Adjusts for minimum sine distortion. (Note: Keep in mind that the D/A converter adjusts must be set for maximum linearity and not minimum sine distortion.)

E. Repeat steps C and D several times because of interaction.

8. USING SCOPE

A. Set RANGE to 100Hz and FREQUENCY and MULTIPLIER to 1.0. Connect VARIABLE PHASE OUTPUT terminated into 50Ω to scope. Set VARIABLE PHASE FUNCTION to sine. Adjust Power Amplifier Gain Adjust and sine D.C. Adjust to obtain peaks of 5.050V ± 10mV.

B. Set VARIABLE PHASE FUNCTION to triangle and adjust triangle amplitude and triangle DC Adjust to obtain peaks of 5.050V ± 10mV.

C. Set VARIABLE PHASE FUNCTION to square and adjust square AMPLITUDE and Square DC Adjust to obtain peaks of 5.050V ± 10mV.

D. Set VARIABLE PHASE FUNCTION to triangle. Engage VARIABLE PHASE POS OFFSET and adjust Fixed D.C. Offset Adjust to 0.000 ± 5mV.

E. Engage VARIABLE PHASE INV Offset and adjust Fixed D.C. Offset for best compromise between steps D and E.

ALL BELOW ADJUSTMENTS ON TOP BOARD (Figure 4.2.0)

9. USING SCOPE

A. Connect SCOPE to REFERENCE OUTPUT. Set FUNCTION to triangle and set Sine DC Adjust and Tri DC Adjust to midrange.

B. Connect a clip lead from the Power Amplifier input to ground (tp1800 and common). Adjust P.A. Balance for 0.000V ± .001V.

C. Move the clip lead to the Preamplifier input and ground (tp1701 and common). Adjust Preamp Bal for 0.000V ± .001V.

D. Move the clip lead to the summing amplifier input and output (tp1501 and tp1550). Adjust sum Amp Bal for 0.000V ± .001V. Remove clip lead.

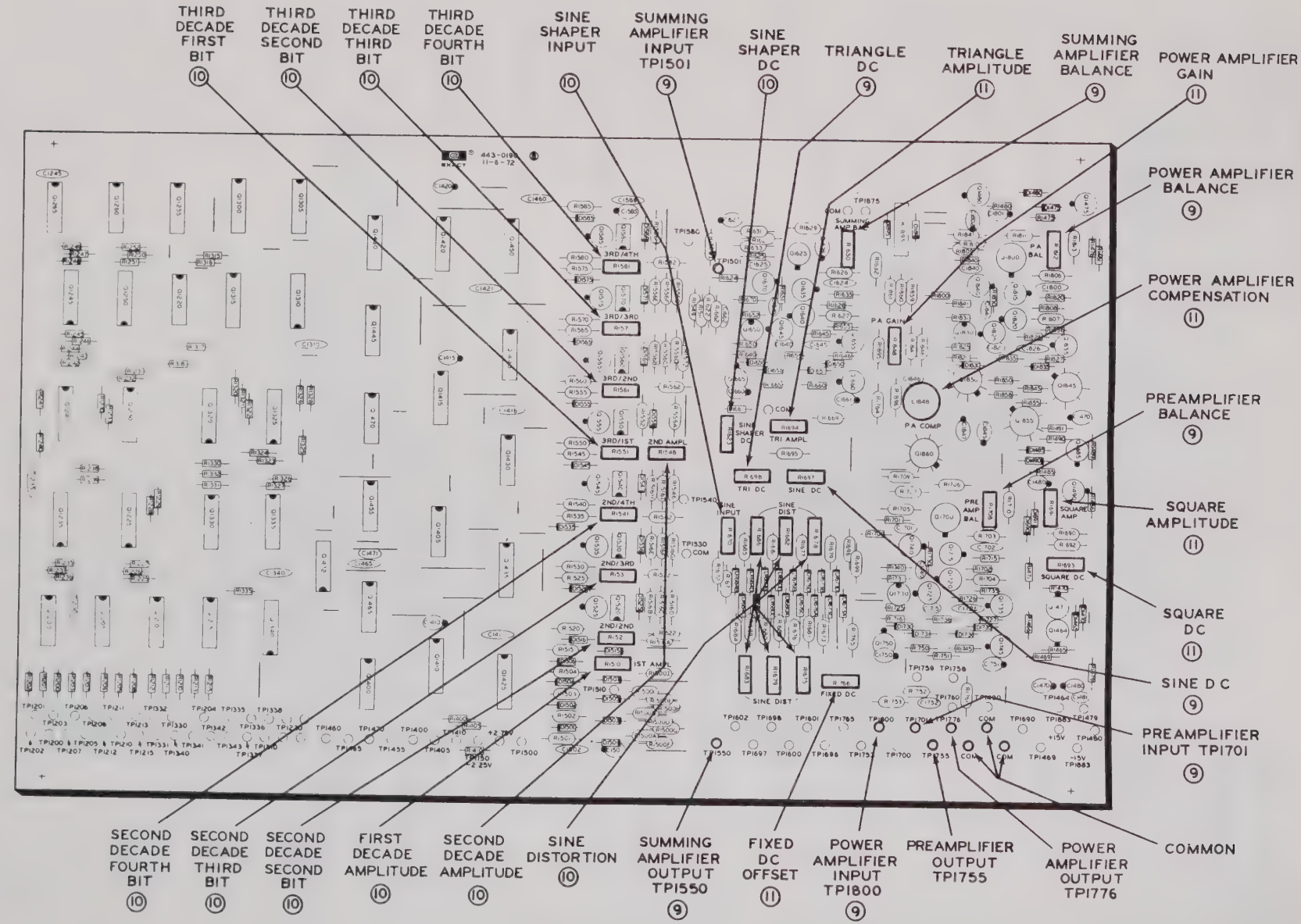

THIRD DECADE FIRST BIT (10)
THIRD DECADE SECOND BIT (10)
THIRD DECADE THIRD BIT (10)
THIRD DECADE FOURTH BIT (10)
SINE SHAPER INPUT (10)
SUMMING AMPLIFIER INPUT TPI501 (9)
SINE SHAPER DC (10)
TRIANGLE DC (9)
TRIANGLE AMPLITUDE (11)
SUMMING AMPLIFIER BALANCE (9)
POWER AMPLIFIER GAIN (11)
POWER AMPLIFIER BALANCE (9)
POWER AMPLIFIER COMPENSATION (11)
PREAMPLIFIER BALANCE (9)
SQUARE AMPLITUDE (11)
SQUARE DC (11)
SINE D C (9)
PREAMPLIFIER INPUT TPI701 (9)
COMMON
POWER AMPLIFIER OUTPUT TPI776
PREAMPLIFIER OUTPUT TPI755
POWER AMPLIFIER INPUT TPI800 (9)
FIXED DC OFFSET (11)
SUMMING AMPLIFIER OUTPUT TPI550 (9)
SINE DISTORTION (10)
SECOND DECADE AMPLITUDE (10)
FIRST DECADE AMPLITUDE (10)
SECOND DECADE SECOND BIT (10)
SECOND DECADE THIRD BIT (10)
SECOND DECADE FOURTH BIT (10)

FIGURE 4.2.0
ADJUSTMENT LOCATION DETAIL

(9) INDICATES CALIBRATION SEQUENCE

10. USING HARMONIC DISTORTION ANALYZER AND OSCILLOSCOPE

A. Set RANGE to 100Hz, MULTIPLIER to 1.00, and FUNCTION to sine. Connect the distortion analyzer to REFERENCE OUTPUT and connect the scope to distortion analyzer output (distortion products). The scope trace should be as in figure 4.10.4. (Some noise is to be expected.)

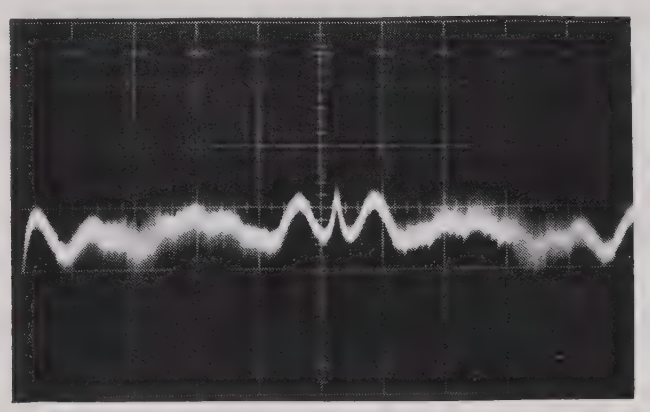


Figure 4.10.4

B. Turn Second Decade Amplitude Adjust. Obtain a scope trace as in figure 4.10.5.

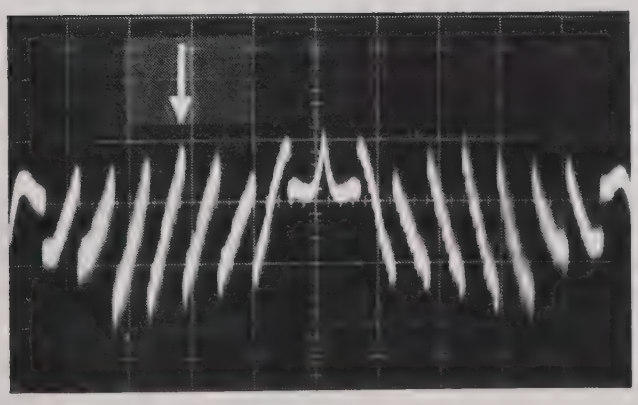


Figure 4.10.5

10. USING HARMONIC DISTORTION ANALYZER AND OSCILLOSCOPE Cont'd

Expand the portion that the arrow points to on figure 4.10.5 and adjust First Decade Amplitude and Second Decade Bit Adjusts to obtain a trace as in figure 4.10.6.

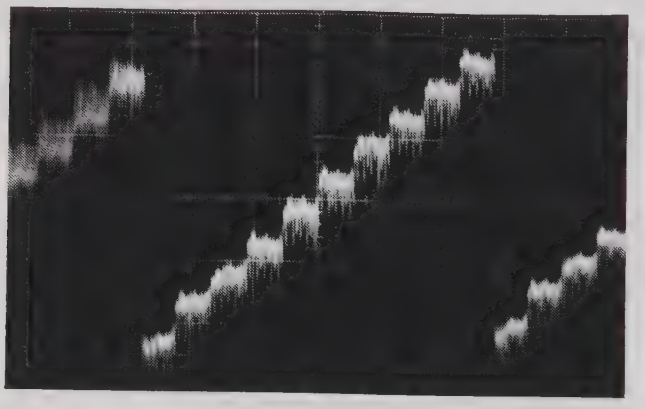


Figure 4.10.6

Now readjust the Second Decade Amplitude Adjust to produce a smooth curve.

C. Reset the scope to again see a trace as in figure 4.10.4. Adjust the Third Decade Bit Adjusts to produce the smoothest possible line.

D. Now adjust the Sine Shaper Input, D.C. and Distortion Adjusts for minimum sine distortion. (Note: Keep in mind that the D/A converter adjusts must be set for maximum linearity and not minimum sine distortion.)

E. Repeat steps C and D several times because ot interaction.

F. Connect VARIABLE PHASE and REFERENCE OUTPUTS, terminated into 50Ω, to scope. Set PHASE lead for 180° and set scope to add the inputs. Set both generators to sine. Readjust REFERENCE Sine Shaper input, D.C. and Distortion Adjusts for minimum signal.

11. USING SCOPE

The amplitudes and D.C. of all waveforms from both generators must match as close as possible in order to maintain the phase lead accuracy.

A. Connect REFERENCE OUTPUT terminated into 50Ω to scope. Set VARIABLE PHASE FUNCTION to sine. Adjust Power Amplifier Gain Adjust and sine D.C. Adjust to obtain peaks of 5.050 ± .010.

B. Set REFERENCE FUNCTION to triangle and adjust triangle amplitude and triangle DC Adjust to obtain peaks of 5.050 ± .010.

C. Set REFERENCE FUNCTION to square and adjust square AMPLITUDE and Square DC Adjust to obtain peaks of 5.050 ± .010.

D. Set Function to triangle. Engage REFERENCE POS OFFSET and adjust Fixed D.C. Offset Adjust to 0.000 ± 5mV.

E. Engage REFERENCE INV Offset and adjust Fixed D.C. Offset for best compromise between steps D and E.

F. Connect VARIABLE PHASE and REFERENCE OUTPUTS to dual trace plug-in. Set PHASE LEAD for 0°. Adjust P.A. Compensation for best possible match of rise and fall times of both generators.

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code #	Manufacturer	Address
00853	Sangamo Western	Pickens, SC
01121	Allen-Bradley Co.	Milwaukee, WI
01295	Texas Instruments	Dallas, TX
02111	Spectrol	City of Ind., CA
02660	Amphenol-Borg	Chicago, IL
02735	RCA Corp.	Somerville, NJ
04713	Motorola	Phoenix, AZ
05820	Wakefield Eng.	Wakefield, MA
07115	Corning Electronics	Bradford, PA
07126	Digitran Co.	Pasadena, CA
07263	Fairchild Semi.	Mt. View, CA
07919	Teledyne Semi.	Hawthorne, CA
09353	Loopco Industries	Twinsburg, OH
10597	Exact Electronics	Tillamook, OR
11237	CTS Keen, Inc.	Paso Robles, CA
12859	Nippon Electronics	Tokyo, Japan
12944	Texas Instruments	Dallas, TX
13103	Thermalloy	Dallas, TX
15112	Gulton Industries	Fullerton, CA
15450	Erie Tech. Prods.	Erie, PA
17856	Siliconix	Santa Clara, CA
18324	Signetics Corp.	Sunnyvale, CA
18722	RCA Corp.	Mountain Top, PA
18786	Micro Power, Inc.	Long Is. City, NY
19701	Mepco/Electra	Mineral Wells, TX
21604	Buckeye Stamping	Columbus, OH
22753	VID Electronics	Hollywood, FL
24546	Corning Glass Works	Bradford, PA
27014	National Semi.	Danbury, CT
28480	Hewlett-Packard	Palo Alto, CA
28520	Neyman Mfg.	Kennilworth, NJ
31433	Kemet Electronics	Greenville, SC
31718	Fairchild Opt-Elec.	Mt. View, CA
31918	IEE Schadow	Eden Prairie, MN
32767	Griffith Plastics	Burlingame, CA
37954	Abenakis Plastiques	Becancour, Que.
50434	Hewlett-Packard	Palo Alto, CA
53021	Sangamo Weston	Springfield, IL
56289	Sprague Elec. Co.	North Adams, MA
71450	CTS Corp.	Elkhart, IN
71950	Centralab	Milwaukee, WI
72619	Amperex Elec Corp.	Brooklyn, NY
72982	Erie Tech. Products	Erie, PA
73445	Amperex Elec.	Hicksville, NY
74840	Illinois Capacitors	Morton Grove, IL
75042	TRW Elec. Comp.	Philadelphia, PA
75173	Cinch-Jones Mfg.	Chicago, IL
76854	Oak Industries	Crystal Lake, IL
77902	Rohm & Haas Co.	Philadelphia, PA
78488	Stackpole Carbon	St. Mary's MA
80126	Pacific Electrocord	Gardena, CA
80740	Beekman Instruments	Fullerton, CA
82389	Switchcraft, Inc.	Orange, IL
83330	H. H. Smith	Brooklyn, NY
84411	TRW Elec. Comp.	Ogallala, NE
88124	CDE/Cornell-Dublier	New York, NY
90201	Mallory Capacitors	Indianapolis, IN
90210	Kilburn Engineering	Chicago, IL
91418	Radio Materials Co.	Chicago, IL
91836	Kings Electronics	Tuckahoe, NY
94375	Plessy Connectors	Commack, NY
95348	Gordos Corp.	Bloomfield, NJ
98978	Int. Elect. Research	Burbank, CA
99515	W-K Industries	Monrovia, CA
99848	Wilco Corp.	Indianapolis, IN

Deleted No.:	Replaced by:
100002	31433
10237	11237
27104	27014

PART	DESCRIPTION	EXACT NO.	MFG
B2102	PILOT LIGHT	1360265	71744
C0122	CAPACITOR, 65-242MFD 15V	2927849	853
C0121	CAPACITOR, 65-242MFD 15V	2927849	853
C0122	CAPACITOR, 2522MFD 35V	2928234	853
C0123	CAPACITOR, 25-242MFD 35V	2928234	853
C0124	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0114	CAPACITOR, 1000 PF DISCAP	2832727	91418
C0111	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0115	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0116	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0150	CAPACITOR, 47PF MICA	2817539	853
C0151	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0152	CAPACITOR, 47PF MICA	2817539	853
C0161	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0165	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0178	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0175	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0190	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0191	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0192	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0232	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0240	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0245	CAPACITOR, 5.5-18PF TRIM	2812711	72982
C0246	CAPACITOR, 120PF MICA	2810537	853
C0247	CAPACITOR, 12PF MICA	2810529	853
C0260	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0270	CAPACITOR, 1000 PF DISCAP	2832020	91418
C0275	CAPACITOR, 0.01 UF DISCAP	2832025	91418
C0277	CAPACITOR, 5.5-18PF TRIM	2812711	72982
C0278	CAPACITOR, 22PF MICA	2810533	853
C0280	CAPACITOR, 5PF MICA	2810501	853
C0285	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0286	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0295	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0296	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0297	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0298	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0300	TO		
C0304	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0305	CAPACITOR, 220PF MICA	2810555	853
C0366	CAPACITOR, 68PF MICA	2817523	853
C0369	CAPACITOR, 68PF MICA	2817523	853
C0375	CAPACITOR, 22PF MICA	2810533	853
C0376	CAPACITOR, 100PF MICA	2810537	853
C0393	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0398	CAPACITOR, 120PF MICA	2810534	853
C0400	CAPACITOR, 68PF MICA	2817523	853
C0405	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0410	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0421	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0425	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0456	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0475	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0481	CAPACITOR, 100PF MICA	2810537	853
C0482	CAPACITOR, 100PF MICA	2810537	853
C0485	CAPACITOR, 100PF MICA	2810537	853
C0486	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0495	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0497	CAPACITOR, 68PF MICA	2812523	853
C0498	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0501	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0502	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0585	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0586	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C0607	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0624	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0625	CAPACITOR, 100PF MICA	2810537	853
C0626	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0627	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0640	CAPACITOR, 1000 PF DISCAP	2832000	91418
C0645	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0660	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0661	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0662	CAPACITOR, 220PF MICA	2810555	853
C0670	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0700	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0701	CAPACITOR, 100PF MICA	2810537	853
C0702	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0703	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0715	CAPACITOR, 1000 PF DISCAP	2832000	91418
C0726	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0748	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0750	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0751	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0752	CAPACITOR, 120PF MICA	2812534	853
C0800	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0821	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0822	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0821	CAPACITOR, 1000 PF DISCAP	2832000	91418
C0826	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C0840	CAPACITOR, 100PF MICA	2817537	853
C0841	CAPACITOR, 5000 PF DISCAP	2832011	91418
C0845	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0846	CAPACITOR, 220PF MICA	2817555	853
C0847	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C0870	CAPACITOR, 1000PF MICA	2810560	853
C0871	CAPACITOR, 1300PF MICA	2810560	853
C0872	CAPACITOR, 1000PF MICA	2810560	853
C0873	CAPACITOR, 1300PF MICA	2810560	853
C1200	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1235	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1245	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1310	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1340	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1410	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1411	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1415	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1416	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1420	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1421	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1460	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1465	CAPACITOR, 0.05 UF DISCAP	2832010	91418

PART	DESCRIPTION	EXACT NO.	MFG
C1470	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1471	CAPACITOR, 47PF MICA	2817539	853
C1480	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1481	CAPACITOR, 5000 PF DISCAP	2832011	91418
C1501	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1502	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1585	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1586	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C1624	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1625	CAPACITOR, 120PF MICA	2810534	853
C1626	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1627	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1642	CAPACITOR, 100 PF DISCAP	2832000	91418
C1645	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1660	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1661	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1662	CAPACITOR, 220PF MICA	2817555	853
C1670	CAPACITOR, 5000 PF DISCAP	2832011	91418
C1701	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1721	CAPACITOR, 120PF MICA	2810537	853
C1702	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1703	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1715	CAPACITOR, 1000 PF DISCAP	2832000	91418
C1726	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1740	CAPACITOR, 5.62 PF DISCAP	2832011	91418
C1750	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1751	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1752	CAPACITOR, 120PF MICA	2810534	853
C1800	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1821	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1821	CAPACITOR, 1000 PF DISCAP	2832000	91418
C1826	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C1842	CAPACITOR, 120PF MICA	2810537	853
C1841	CAPACITOR, 5000 PF DISCAP	2832011	91418
C1845	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1846	CAPACITOR, 220PF MICA	2817555	853
C1847	CAPACITOR, 6.8 MFD 35 VOLT	2927843	122222
C1848	CAPACITOR, 8-50PF TRIM	2812722	72982
C1870	CAPACITOR, 1000PF MICA	2817560	853
C1871	CAPACITOR, 1000PF MICA	2817560	853
C1872	CAPACITOR, 1000PF MICA	2817560	853
C1873	CAPACITOR, 1000PF MICA	2817560	853
D0100	TO		
D0103	DIODE, 1N4719	1524719	4713
D0104	RECTIFIER BRIDGE, MDA920A-3	1524920	4713
D0110	DIODE, 1N4221	1524221	1295
D0111	DIODE, 1N4221	1524221	1295
D0150	DIODE, 1N4221	1524221	1295
D0160	DIODE, 1N4221	1524221	1295
D0185	DIODE, 1N914	1522914	7910
D0190	DIODE, 1N4221	1524221	1295
D0191	DIODE, 1N4221	1524221	1295
D0193	DIODE, 1N757	1527757	1295
D0220	DIODE, 1N914	1522914	7910
D0221	DIODE, 1N914	1522914	7910
D0265	DIODE, HOT CARRIER	1522835	10597
D0266	DIODE, HOT CARRIER	1522835	10597
D0282	DIODE, HOT CARRIER	1522835	10597
D0281	DIODE, HOT CARRIER	1522835	10597
D0282	DIODE, HOT CARRIER	1522835	10597
D0283	DIODE, HOT CARRIER	1522835	10597
D0285	DIODE, HOT CARRIER	1522835	10597
D0286	DIODE, HOT CARRIER	1522835	10597
D0287	TO		
D0292	DIODE, 1N914	1522914	7910
D0295	DIODE, 1N914	1522914	7910
D0310	DIODE, 1N914	1522914	7910
D0311	DIODE, 1N914	1522914	7910
D0375	DIODE, 1N914	1522914	7910
D0376	DIODE, 1N914	1522914	7910
D0377	DIODE, HOT CARRIER	1522835	10597
D0378	DIODE, 1N914	1522914	7910
D0379	DIODE, 1N914	1522914	7910
D0380	DIODE, 1N751A	1527751	79242
D0385	DIODE, 1N756	1527756	1295
D0500	TO		
D0507	DIODE, 1N914	1522914	7910
D0515	DIODE, 1N914	1522914	7910
D0516	DIODE, 1N914	1522914	7910
D0525	DIODE, 1N914	1522914	7910
D0526	DIODE, 1N914	1522914	7910
D0535	DIODE, 1N914	1522914	7910
D0536	DIODE, 1N914	1522914	7910
D0545	DIODE, 1N914	1522914	7910
D0546	DIODE, 1N914	1522914	7910
D0555	DIODE, 1N914	1522914	7910
D0555A	DIODE, 1N914	1522914	7910
D0565	DIODE, 1N914	1522914	7910
D0566	DIODE, 1N914	1522914	7910
D0575	DIODE, 1N914	1522914	7910
D0576	DIODE, 1N914	1522914	7910
D0585	DIODE, 1N914	1522914	7910
D0586	DIODE, 1N914	1522914	7910
D0602	DIODE, 1N914	1522914	7910
D0605	DIODE, 1N914	1522914	7910
D0652	DIODE, 1N914	1522914	7910
D0651	DIODE, 1N914	1522914	7910
D0655	DIODE, 1N914	1522914	7910
D0656	DIODE, 1N914	1522914	7910
D0673	DIODES, MATCHED SET 1N914	1534914	10597
D0674	DIODES, MATCHED SET 1N914	1534914	10597
D0675	DIODES, MATCHED SET 1N914	1534914	10597
D0684	DIODES, MATCHED SET 1N914	1534914	10597
D0691	DIODE, 1N914	1522914	7910
D0731	DIODE, 1N914	1522914	7910
D0735	DIODE, 1N914	1522914	7910
D0738	DIODE, 1N914	1522914	7910
D0830	DIODE, 1N914	1522914	7910
D0835	DIODE, 1N914	1522914	7910

PART	DESCRIPTION	EXACT NO	MFG
D2895	DIODE, 1N914	1527914	7910
D2896	DIODE, 1N914	1527914	7910
D1465	DIODE, 1N914	1527914	7910
D1472	DIODE, 1N914	1527914	7910
D1475	DIODE, 1N914	1527914	7910
D1482	DIODE, 1N914	1527914	7910
D1485	DIODE, 1N914	1527914	7910
D1490	DIODE, 1N914	1527914	7910
D1492	TO		
D1527	DIODE, 1N914	1527914	7910
D1515	DIODE, 1N914	1527914	7910
D1516	DIODE, 1N914	1527914	7910
D1525	DIODE, 1N914	1527914	7910
D1526	DIODE, 1N914	1527914	7910
D1535	DIODE, 1N914	1527914	7910
D1536	DIODE, 1N914	1527914	7910
D1545	DIODE, 1N914	1527914	7910
D1546	DIODE, 1N914	1527914	7910
D1555	DIODE, 1N914	1527914	7910
D1556	DIODE, 1N914	1527914	7910
D1565	DIODE, 1N914	1527914	7910
D1566	DIODE, 1N914	1527914	7910
D1575	DIODE, 1N914	1527914	7910
D1576	DIODE, 1N914	1527914	7910
D1585	DIODE, 1N914	1527914	7910
D1586	DIODE, 1N914	1527914	7910
D1650	DIODE, 1N914	1527914	7910
D1651	DIODE, 1N914	1527914	7910
D1655	DIODE, 1N914	1527914	7910
D1656	DIODE, 1N914	1527914	7910
D1673	DIODES, MATCHED SET 1N914	1530914	10597
D1676	DIODES, MATCHED SET 1N914	1530914	10597
D1682	DIODES, MATCHED SET 1N914	1530914	10597
D1684	DIODES, MATCHED SET 1N914	1530914	10597
D1692	DIODE, 1N914	1527914	7910
D1691	DIODE, 1N914	1527914	7910
D1730	DIODE, 1N914	1527914	7910
D1731	DIODE, 1N914	1527914	7910
D1735	DIODE, 1N914	1527914	7910
D1736	DIODE, 1N914	1527914	7910
D1834	DIODE, 1N914	1527914	7910
D1835	DIODE, 1N914	1527914	7910
D1895	DIODE, 1N914	1527914	7910
D1896	DIODE, 1N914	1527914	7910
K0895	RELAY, SPST REED 5 VOLT	2600328	10597
K1795	RELAY, SPST REED 5 VOLT	2600328	10597
L2282	BEAD, FERRITE 6323	1140034	1121
L0281	BEAD, FERRITE 6323	1140034	1121
L0870	CHOKE, 4.7 MICROHENRY	1140033	76493
L0871	CHOKE, 4.7 MICROHENRY	1140033	76493
L1870	CHOKE, 4.7 MICROHENRY	1140033	76493
L1871	CHOKE, 4.7 MICROHENRY	1140033	76493
Q0103	TRANSISTOR, 2N4918	1564918	4713
Q0105	TRANSISTOR, MJE3740	1563740	4713
Q0110	INTEGRATED CIRCUIT, UA723	1582212	7263
Q0115	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0122	TRANSISTOR, 2N2905	1562905	1295
Q0123	TRANSISTOR, 2N4918	1564918	4713
Q0125	TRANSISTOR, MJE3740	1563740	4713
Q0130	TRANSISTOR, EN2484	1562484	7263
Q0135	TRANSISTOR, 2N4250	1564250	7263
Q0142	CONTROLLED RECTIFIER, 2N4167	1564167	4713
Q0145	TRANSISTOR, MJE3055	1563055	5277
Q0150	INTEGRATED CIRCUIT, UA723	1582012	7263
Q0155	TRANSISTOR, MJE3355	1563855	5277
Q0160	INTEGRATED CIRCUIT, UA723	1582012	7263
Q0165	TRANSISTOR, 2N4121	1564121	7263
Q0172	TRANSISTOR, 2N4121	1564121	7263
Q0175	TRANSISTOR, 2N2219	1562219	1295
Q0182	TRANSISTOR, MJE3740	1563740	4713
Q0185	TRANSISTOR, 2N2219	1562219	1295
Q0190	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0195	TRANSISTOR, 2N2905	1562905	1295
Q0197	TRANSISTOR, MJE3740	1563740	4713
Q0199	TRANSISTOR, 2N2219	1562219	1295
Q0222	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0232	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0235	TRANSISTOR, 2N3485	1565485	4713
Q0242	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0245	TRANSISTOR, 2N4250	1564250	7263
Q0252	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0255	TRANSISTOR, 2N4250	1564250	7263
Q0262	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0265	TRANSISTOR, EN2484	1562484	7263
Q0277	TRANSISTORS, MATCHED 2N5465	1575465	10597
Q0279	TRANSISTORS, MATCHED PAIR MPS3646	1572008	10597
Q0282	TRANSISTORS, MATCHED TIS87	1572087	10597
Q0285	TRANSISTOR, 2N4250	1564250	7263
Q0292	TRANSISTOR, 2N4250	1564250	7263
Q0295	TRANSISTOR, MPS3563	1563563	4713
Q0302	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0305	INTEGRATED CIRCUIT, SN7402N	1582011	1295
Q0312	INTEGRATED CIRCUIT, SN7402N	1582021	1295
Q0315	INTEGRATED CIRCUIT, SN7402N	1582011	1295
Q0322	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0325	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0332	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0335	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0342	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0345	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0352	INTEGRATED CIRCUIT, SN7402N	1582024	1295
Q0355	INTEGRATED CIRCUIT, SN74151N	1582041	1295
Q0362	INTEGRATED CIRCUIT, SN7402N	1582011	1295
Q0365	INTEGRATED CIRCUIT, SN7402N	1582011	1295
Q0372	INTEGRATED CIRCUIT, SN7402N	1582033	1295
Q0375	INTEGRATED CIRCUIT, SN7402N	1582011	1295
Q0390	INTEGRATED CIRCUIT, UA710C	1582027	7263
Q0402	INTEGRATED CIRCUIT, SN7410N	1582032	1295
Q0415	INTEGRATED CIRCUIT, SN7402N	1582021	1295
Q0418	INTEGRATED CIRCUIT, SN74193N	1582034	1295
Q0422	INTEGRATED CIRCUIT, SN7423N	1582036	1295
Q0425	INTEGRATED CIRCUIT, SN7402N	1582037	1295
Q0432	INTEGRATED CIRCUIT, SN74S32N	1582044	1295
Q0435	INTEGRATED CIRCUIT, SN74S38N	1582038	1295
Q0442	INTEGRATED CIRCUIT, SN7410N	1582032	1295
Q0445	INTEGRATED CIRCUIT, SN74190N	1582034	1295
Q0452	INTEGRATED CIRCUIT, SN7408N	1582011	1295
Q0465	INTEGRATED CIRCUIT, SN74190N	1582034	1295
Q0472	INTEGRATED CIRCUIT, SN7423N	1582036	1295
Q0480	INTEGRATED CIRCUIT, SN7410N	1582032	1295
Q0485	INTEGRATED CIRCUIT, SN74S112N	1582039	1295
Q0492	INTEGRATED CIRCUIT, SN74S20N	1582044	1295
Q0493	INTEGRATED CIRCUIT, SN74S20N	1582044	1295
Q0495	INTEGRATED CIRCUIT, SN7423N	1582033	1295
Q0497	INTEGRATED CIRCUIT, SN7420N	1582011	1295
Q0520	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q0525	TRANSISTOR, 2N4250	1564250	7263
Q0530	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0535	TRANSISTOR, 2N4250	1564250	7263
Q0542	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0545	TRANSISTOR, 2N4250	1564250	7263
Q0550	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0555	TRANSISTOR, 2N4250	1564250	7263
Q0560	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0565	TRANSISTOR, 2N4250	1564250	7263
Q0572	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0575	TRANSISTOR, 2N4250	1564250	7263
Q0580	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q0585	TRANSISTOR, 2N4250	1564250	7263
Q0600	TRANSISTOR, TIS87	1562087	1295
Q0625	TRANSISTOR, 2N4121	1564121	7263
Q0625	TRANSISTOR, 2N5454	1565454	81637
Q0635	TRANSISTOR, 2N4250	1564250	7263
Q0640	TRANSISTOR, 2N4250	1564250	7263
Q0645	TRANSISTOR, MPS6543	1566543	4713
Q0650	TRANSISTOR, MPS3646	1563646	4713
Q0655	TRANSISTOR, 2N4121	1564121	7263
Q0660	TRANSISTOR, TIS87	1562087	1295
Q0665	TRANSISTOR, 2N4121	1564121	7263
Q0670	TRANSISTOR, 2N3485	1565485	4713
Q0700	TRANSISTOR, 2N4045	1564045	7263
Q0715	TRANSISTOR, 2N4250	1564250	7263
Q0720	TRANSISTOR, 2N4250	1564250	7263
Q0725	TRANSISTOR, MPS6543	1566543	4713
Q0732	TRANSISTOR, TIS87	1562087	1295
Q0735	TRANSISTOR, 2N4121	1564121	7263
Q0740	TRANSISTOR, 2N3485	1565485	4713
Q0745	TRANSISTOR, TIS87	1562087	1295
Q0750	TRANSISTOR, 2N4121	1564121	7263
Q0800	TRANSISTOR, 2N4045	1564045	7263
Q0815	TRANSISTOR, 2N4250	1564250	7263
Q0820	TRANSISTOR, 2N4250	1564250	7263
Q0825	TRANSISTOR, MPS6543	1566543	4713
Q0830	TRANSISTOR, TIS87	1562087	1295
Q0835	TRANSISTOR, 2N4121	1564121	7263
Q0840	TRANSISTOR, 2N3485	1565485	4713
Q0845	TRANSISTOR, 2N2219	1562219	1295
Q0850	TRANSISTOR, 2N2905	1562905	1295
Q0855	TRANSISTOR, 2N2219	1562219	1295
Q0860	TRANSISTOR, 2N2905	1562905	1295
Q1200	INTEGRATED CIRCUIT, SN7402N	1582021	1295
Q1205	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1210	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1215	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1222	INTEGRATED CIRCUIT, SN7412N	1582032	1295
Q1225	INTEGRATED CIRCUIT, SN74184N	1582184	1295
Q1230	INTEGRATED CIRCUIT, SN74184N	1582184	1295
Q1240	INTEGRATED CIRCUIT, SN74184N	1582184	1295
Q1245	INTEGRATED CIRCUIT, SN74184N	1582184	1295
Q1250	INTEGRATED CIRCUIT, SN74184N	1582184	1295
Q1255	INTEGRATED CIRCUIT, SN7486N	1582035	1295
Q1260	INTEGRATED CIRCUIT, SN7486N	1582035	1295
Q1265	INTEGRATED CIRCUIT, SN7486N	1582035	1295
Q1300	INTEGRATED CIRCUIT, SN7483N	1582083	1295
Q1305	INTEGRATED CIRCUIT, SN7483N	1582083	1295
Q1310	INTEGRATED CIRCUIT, SN7483N	1582083	1295
Q1315	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1320	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1325	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1330	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1335	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1340	INTEGRATED CIRCUIT, SN74185N	1582185	1295
Q1400	INTEGRATED CIRCUIT, SN7402N	1582021	1295
Q1405	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1410	INTEGRATED CIRCUIT, SN74190N	1582034	1295
Q1415	INTEGRATED CIRCUIT, SN74190N	1582034	1295
Q1420	INTEGRATED CIRCUIT, SN74192N	1582034	1295
Q1425	INTEGRATED CIRCUIT, SN7423N	1582036	1295
Q1430	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1435	INTEGRATED CIRCUIT, SN7423N	1582036	1295
Q1440	INTEGRATED CIRCUIT, SN7400N	1582011	1295
Q1445	INTEGRATED CIRCUIT, SN74S08N	1582044	1295
Q1452	INTEGRATED CIRCUIT, SN7423N	1582036	1295
Q1455	INTEGRATED CIRCUIT, SN74S10N	1582038	1295
Q1462	INTEGRATED CIRCUIT, SN74S112N	1582039	1295
Q1464	TRANSISTOR, MPS3646	1563646	4713
Q1465	INTEGRATED CIRCUIT, SN74S08N	1582044	1295
Q1470	INTEGRATED CIRCUIT, SN74S20N	1582045	1295
Q1471	TRANSISTOR, 2N4121	1564121	7263
Q1472	INTEGRATED CIRCUIT, SN74S20N	1582044	1295
Q1475	TRANSISTOR, MPS3646	1563646	4713
Q1482	TRANSISTOR, 2N4121	1564121	7263
Q1485	TRANSISTOR, MPS3646	1563646	4713
Q1490	TRANSISTOR, 2N4121	1564121	7263
Q1520	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q1525	TRANSISTOR, 2N4250	1564250	7263
Q1530	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q1535	TRANSISTOR, 2N4250	1564250	7263
Q1540	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q1545	TRANSISTOR, 2N4250	1564250	7263
Q1555	TRANSISTOR, 2N4250	1564250	7263
Q1560	OPERATIONAL AMPLIFIER, UA741	1582010	7263
Q1565	TRANSISTOR, 2N4250	1564250	7263

PART	DESCRIPTION	EXACT NO	MFG
Q1570	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1575	TRANSISTOR, 2N4250	1564250	7263
Q1580	OPERATIONAL AMPLIFIER, UA741	1580010	7263
Q1585	TRANSISTOR, 2N4250	1564250	7263
Q1625	TRANSISTOR, 2N5454	1565454	61637
Q1635	TRANSISTOR, 2N4250	1564250	7263
Q1640	TRANSISTOR, 2N4250	1564250	7263
Q1645	TRANSISTOR, MPS6543	1566543	4713
Q1650	TRANSISTOR, TIS87	1560087	1295
Q1655	TRANSISTOR, 2N4121	1564121	7263
Q1660	TRANSISTOR, TIS87	1560087	1295
Q1665	TRANSISTOR, 2N4121	1564121	7263
Q1670	TRANSISTOR, 2N5485	1565485	4713
Q1700	TRANSISTOR, 2N4045	1564045	7263
Q1715	TRANSISTOR, 2N4250	1564250	7263
Q1720	TRANSISTOR, 2N4250	1564250	7263
Q1725	TRANSISTOR, MPS6543	1566543	4713
Q1730	TRANSISTOR, TIS87	1560087	1295
Q1735	TRANSISTOR, 2N4121	1564121	7263
Q1740	TRANSISTOR, 2N5485	1565485	4713
Q1745	TRANSISTOR, TIS87	1560087	1295
Q1750	TRANSISTOR, 2N4121	1564121	7263
Q1800	TRANSISTOR, 2N4045	1564045	7263
Q1815	TRANSISTOR, 2N4250	1564250	7263
Q1820	TRANSISTOR, 2N4250	1564250	7263
Q1825	TRANSISTOR, MPS6543	1566543	4713
Q1830	TRANSISTOR, TIS87	1560087	1295
Q1835	TRANSISTOR, 2N4121	1564121	7263
Q1842	TRANSISTOR, 2N5485	1565485	4713
Q1845	TRANSISTOR, 2N2219	1562219	1295
Q1850	TRANSISTOR, 2N2905	1562905	1295
Q1855	TRANSISTOR, 2N2219	1562219	1295
Q1860	TRANSISTOR, 2N2905	1562905	1295
R0100	RESISTOR, 68K OHM 1/4W 5% CARBON	3073683	1121
R0105	RESISTOR, 0.1 OHM WIREWOUND	3080001	75042
R0106	RESISTOR, 56 OHM 1/4W 5% CARBON	3072560	1121
R0112	RESISTOR, 14200 OHM 1/4W 1% METAL FILM	3131402	7115
R0111	POTENTIOMETER, 2K OHM PC TRIM	3110139	78488
R0112	RESISTOR, 9310 OHM 1/4W 1% METAL FILM	3139311	7115
R0115	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0116	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0117	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
R0118	POTENTIOMETER, 2K OHM PC TRIM	3110139	78488
R0120	RESISTOR, 680 OHM 1/4W 5% CARBON	3076881	1121
R0121	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071092	1121
R0122	RESISTOR, 22 OHM 1/4W 5% CARBON	3072220	1121
R0133	RESISTOR, 0.1 OHM WIREWOUND	3080001	75042
R0135	RESISTOR, 300 OHM 1/4W 5% CARBON	3073091	1121
R0136	RESISTOR, 5.6 OHM THERMISTOR	3174052	1295
R0137	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0138	RESISTOR, 1910 OHM 1/4W 1% METAL FILM	3131911	7115
R0139	RESISTOR, 5000 OHM THERMISTOR	3175001	1295
R0140	RESISTOR, 120 OHM 1/4W 5% CARBON	3071121	1121
R0141	RESISTOR, 1600 OHM 1/4W 5% CARBON	3071162	1121
R0145	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0150	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0151	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0152	RESISTOR, 5620 OHM 1/4W 1% METAL FILM	3135621	7115
R0153	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0155	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0157	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0161	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R0162	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0163	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0165	RESISTOR, 5100 OHM 1/4W 5% CARBON	3075112	1121
R0166	RESISTOR, 5600 OHM 1/4W 5% CARBON	3075562	1121
R0167	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0170	RESISTOR, 5600 OHM 1/4W 5% CARBON	3075562	1121
R0171	RESISTOR, 5600 OHM 1/4W 5% CARBON	3075562	1121
R0172	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0173	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0174	RESISTOR, 12700 OHM 1/4W 1% METAL FILM	3131272	7115
R0175	RESISTOR, 360 OHM 1/4W 5% CARBON	3073361	1121
R0176	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001	7115
R0177	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0178	RESISTOR, 15K OHM 1/4W 5% CARBON	3071533	1121
R0181	RESISTOR, 0.5 OHM WIREWOUND	3080005	75042
R0185	RESISTOR, 13K OHM 1/4W 5% CARBON	3071333	1121
R0192	RESISTOR, 22100 OHM 1/4W 1% METAL FILM	3132212	7115
R0191	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0192	RESISTOR, 15000 OHM 1/4W 1% METAL FILM	3131502	7115
R0193	RESISTOR, SELECTED VALUE		
R0194	RESISTOR, 8060 OHM 1/4W 1% METAL FILM	3138061	7115
R0195	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071092	1121
R0196	RESISTOR, 10K OHM 1/4W 5% CARBON	3071103	1121
R0197	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3410010	1121
R0198	RESISTOR, 34600 OHM 1/4W 1% METAL FILM	3133462	7115
R0201	TO		
R0212	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000	7115
R0213	RESISTOR, SELECTED VALUE		
R0215	RESISTOR, 1822 OHM 1/4W 1% METAL FILM	3131821	7115
R0216	POTENTIOMETER, 250 OHM	3110145	71450
R0218	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134022	7115
R0222	RESISTOR, 4700 OHM 1/4W 5% CARBON	3074722	1121
R0221	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0222	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0224	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0225	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0226	RESISTOR, 1000K OHM 1/4W 5% CARBON	3071005	1121
R0227	RESISTOR, 9532 OHM 1/4W 1% METAL FILM	3139531	7115
R0228	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0229	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531	7115
R0232	RESISTOR, 1022 OHM 1/4W 1% METAL FILM	3131021	7115
R0231	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990	7115
R0232	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0235	RESISTOR, 1202 OHM 1/4W 1% METAL FILM	3131201	7115
R0241	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0245	RESISTOR, 820 OHM 1/4W 1% METAL FILM	3138202	7115
R0246	RESISTOR, 100 OHM 1/4W 5% CARBON	3071101	1121
R0650	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0251	RESISTOR, 1200 OHM 1/4W 1% METAL FILM	3131201	7115
R0255	RESISTOR, 1820 OHM 1/4W 1% METAL FILM	3131801	7115
R0262	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0265	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750	7115
R0266	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0275	RESISTOR, 301 OHM 1/2W 1% METAL FILM	3103010	7115
R0276	RESISTOR, 499 OHM 1/2W 1% METAL FILM	3104990	7115
R0277	RESISTOR, 715 OHM 1/4W 1% METAL FILM	3137150	7115
R0280	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0281	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221	7115
R0282	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020	7115
R0283	RESISTOR, 301 OHM 1/4W 1% METAL FILM	3133010	7115
R0285	RESISTOR, 221 OHM 1/2W 1% METAL FILM	3102210	7115
R0290	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0291	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821	1121
R0295	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0296	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R0297	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0304	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0305	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0306	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0315	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0316	TO		
R0318	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0364	RESISTOR, 3320 OHM 1/4W 5% CARBON	3073332	1121
R0365	RESISTOR, 2220 OHM 1/4W 5% CARBON	3072222	1121
R0366	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0367	RESISTOR, 3320 OHM 1/4W 5% CARBON	3073332	1121
R0368	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0369	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0375	RESISTOR, 619 OHM 1/4W 1% METAL FILM	3136190	7115
R0376	RESISTOR, 470 OHM 1/4W 5% CARBON	3074711	1121
R0377	RESISTOR, 470 OHM 1/4W 5% CARBON	3074711	1121
R0380	RESISTOR, 316K OHM 1/4W 1% METAL FILM	3133163	7115
R0381	RESISTOR, 27K OHM 1/4W 5% CARBON	3072273	1121
R0382	RESISTOR, 10K OHM 1/4W 5% CARBON	3071103	1121
R0383	RESISTOR, 10K OHM 1/4W 5% CARBON	3071103	1121
R0384	RESISTOR, 1100 OHM 1/4W 5% CARBON	3071112	1121
R0385	POTENTIOMETER, 10K OHM 2 WATT	3110113	71450
R0386	RESISTOR, 360 OHM 1/2W 5% CARBON	3010361	1121
R0387	RESISTOR, 33K OHM 1/4W 5% CARBON	3073333	1121
R0410	TO		
R0413	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0445	TO		
R0448	RESISTOR, 22K OHM 1/4W 5% CARBON	3072222	1121
R0465	TO		
R0468	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0485	RESISTOR, 270 OHM 1/4W 5% CARBON	3072271	1121
R0490	RESISTOR, 2220 OHM 1/4W 5% CARBON	3072222	1121
R0496	RESISTOR, 3320 OHM 1/4W 5% CARBON	3073332	1121
R0497	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0498	RESISTOR, 2200 OHM 1/4W 5% CARBON	3072222	1121
R0499	RESISTOR, 3300 OHM 1/4W 5% CARBON	3073332	1121
R0500	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R0501	TO		
R0504	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0510	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0511	RESISTOR, 9310 OHM 1/4W 1% METAL FILM	3139311	7115
R0515	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0516	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R0520	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0521	POTENTIOMETER, 250 OHM	3110145	71450
R0522	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0525	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0530	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0531	POTENTIOMETER, 250 OHM	3110145	71450
R0532	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0535	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0540	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0541	POTENTIOMETER, 250 OHM	3110145	71450
R0542	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0545	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R0546	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R0548	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0549	RESISTOR, 909 OHM 1/4W 1% METAL FILM	3139099	7115
R0550	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0551	POTENTIOMETER, 250 OHM	3110145	71450
R0552	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0555	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R0556	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R0560	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0561	POTENTIOMETER, 250 OHM	3110145	71450
R0562	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0565	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R0570	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135921	7115
R0571	POTENTIOMETER, 250 OHM	3110145	71450
R0572	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135921	7115
R0575	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R0580	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0581	POTENTIOMETER, 250 OHM	3110145	71450
R0582	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R0585	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R0600	RESISTOR, 5620 OHM 1/4W 5% CARBON	3075562	1121
R0601	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0605	RESISTOR, 5600 OHM 1/4W 5% CARBON	3075562	1121
R0606	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100	1121
R0607	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101	1121
R0621	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0622	RESISTOR, 11322 OHM 1/4W 1% METAL FILM	3131132	7115
R0623	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R0624	RESISTOR, 1000 OHM 1/4W 5% CARBON	3071092	1121
R0625	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680	1121
R0626	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0627	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0628	RESISTOR, 1202 OHM 1/4W 5% CARBON	3071202	1121
R0629	RESISTOR, 12000 OHM 1/4W 1% METAL FILM	3131002	7115
R0630	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0631	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0632	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0633	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0635	RESISTOR, 15K OHM 1/4W 5% CARBON	3071533	1121
R0640	RESISTOR, 11K OHM 1/4W 5% CARBON	3071113	1121
R0645	RESISTOR, 4320 OHM 1/4W 1% METAL FILM	3134321	7115
R0646	RESISTOR, 360 OHM 1/4W 5% CARBON	3073361	1121

PART	DESCRIPTION	EXACT NO	MFG
R0650	RESISTOR, 160 OHM 1/4W 5% CARBON	3270161	1121
R0651	RESISTOR, 100K OHM 1/4W 5% CARBON	3270104	1121
R0652	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R0655	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0656	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0660	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R0661	RESISTOR, 47 OHM 1/4W 5% CARBON	3270470	1121
R0662	RESISTOR, 787 OHM 1/4W 1% METAL FILM	3137870	7115
R0665	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R0669	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0670	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0671	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0672	RESISTOR, 15.8 OHM 1/4W 1% METAL FILM	3130158	7115
R0673	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
R0674	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
R0675	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0676	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
R0677	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
R0678	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0679	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0680	RESISTOR, 6810 OHM 1/4W 1% METAL FILM	3136811	7115
R0681	RESISTOR, 6810 OHM 1/4W 1% METAL FILM	3136811	7115
R0682	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0683	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0684	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
R0685	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115
R0686	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R0687	RESISTOR, 45.3 OHM 1/4W 1% METAL FILM	3130453	7115
R0688	RESISTOR, 93.1 OHM 1/4W 1% METAL FILM	3139931	7115
R0689	RESISTOR, 287 OHM 1/4W 1% METAL FILM	3132872	7115
R0690	RESISTOR, 1270 OHM 1/4W 1% METAL FILM	3131271	7115
R0691	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0692	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0693	POTENTIOMETER, 250 OHM	3110145	71450
R0694	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R0695	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270	7115
R0696	RESISTOR, 210K OHM 1/4W 1% METAL FILM	3132103	7115
R0697	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0698	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R0699	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3132499	7115
R0700	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R0701	RESISTOR, 68 OHM 1/4W 5% CARBON	3270680	1121
R0702	RESISTOR, 1000 OHM 1/4W 5% CARBON	3271102	1121
R0703	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0704	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0705	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0706	RESISTOR, 10K OHM 1/4W 1% METAL FILM	3131002	7115
R0707	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0708	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0709	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0710	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0715	RESISTOR, 15K OHM 1/4W 5% CARBON	3270153	1121
R0716	RESISTOR, 11K OHM 1/4W 5% CARBON	3270113	1121
R0725	RESISTOR, 160 OHM 1/4W 5% CARBON	3270161	1121
R0726	RESISTOR, 4300 OHM 1/4W 5% CARBON	3270432	1121
R0727	RESISTOR, 360 OHM 1/4W 5% CARBON	3270361	1121
R0732	RESISTOR, 100K OHM 1/4W 5% CARBON	3270104	1121
R0735	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R0736	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0740	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0745	RESISTOR, 10K OHM 1/4W 5% CARBON	3270103	1121
R0750	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R0751	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R0752	RESISTOR, 47 OHM 1/4W 5% CARBON	3270470	1121
R0753	RESISTOR, 681 OHM 1/4W 1% METAL FILM	3136810	7115
R0759	RESISTOR, 681 OHM 1/4W 1% METAL FILM	3136810	7115
R0760	RESISTOR, 1691 OHM 1/4W 1% METAL FILM	3131691	7115
R0761	POTENTIOMETER, 500 OHM 2W	3110330	44655
R0763	RESISTOR, 45.3 OHM 1/4W 1% METAL FILM	3130453	7115
R0764	POTENTIOMETER, 2,5K OHM 2W	3110329	44655
R0765	RESISTOR, 2320 OHM 1/4W 1% METAL FILM	3132321	7115
R0766	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741	7115
R0775	POTENTIOMETER, 250 OHM	3110145	71450
R0800	RESISTOR, 2700 OHM 1/4W 5% CARBON	3270202	1121
R0807	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R0808	RESISTOR, 1000 OHM 1/4W 5% CARBON	3271102	1121
R0809	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R0810	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R0811	RESISTOR, 10K OHM 1/4W 1% METAL FILM	3131002	7115
R0812	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R0813	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0814	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R0820	RESISTOR, 15K OHM 1/4W 5% CARBON	3270153	1121
R0821	RESISTOR, 11K OHM 1/4W 5% CARBON	3270113	1121
R0825	RESISTOR, 160 OHM 1/4W 5% CARBON	3270161	1121
R0826	RESISTOR, 4300 OHM 1/4W 5% CARBON	3270432	1121
R0827	RESISTOR, 360 OHM 1/4W 5% CARBON	3270361	1121
R0830	RESISTOR, 100K OHM 1/4W 5% CARBON	3270104	1121
R0831	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R0835	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0836	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R0840	RESISTOR, 68 OHM 1/4W 5% CARBON	3270680	1121
R0841	RESISTOR, 10K OHM 1/4W 5% CARBON	3270103	1121
R0845	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R0846	RESISTOR, 1580 OHM 1/4W 1% METAL FILM	3131581	7115
R0847	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R0848	POTENTIOMETER, 250 OHM	3110145	71450
R0850	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R0855	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R0858	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R0859	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0860	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0861	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500	7115
R0862	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0863	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R0864	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3133348	7115
R0865	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3134412	7115
R0866	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3134412	7115
R0867	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3130100	7115
R0868	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3134464	7115
R0869	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3134464	7115
R0870	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3193163	7115

PART	DESCRIPTION	EXACT NO	MFG
R1200	TO		
R1203	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1205	TO		
R1208	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1210	TO		
R1213	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1215	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1225	TO		
R1233	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1235	TO		
R1252	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1315	TO		
R1318	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1320	TO		
R1332	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1335	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1400	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1405	RESISTOR, 2200 OHM 1/4W 5% CARBON	3270222	1121
R1410	RESISTOR, 470 OHM 1/4W 5% CARBON	3270471	1121
R1465	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1466	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1469	RESISTOR, 100 OHM 1/4W 5% CARBON	3270101	1121
R1470	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1471	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1475	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1476	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1480	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1481	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1485	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1486	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1489	RESISTOR, 100 OHM 1/4W 5% CARBON	3270101	1121
R1490	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1491	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1499	RESISTOR, 100 OHM 1/4W 5% CARBON	3270101	1121
R1500	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R1501	TO		
R1504	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1510	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1511	RESISTOR, 9310 OHM 1/4W 1% METAL FILM	3139311	7115
R1515	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1516	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R1520	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1521	POTENTIOMETER, 250 OHM	3110145	71450
R1522	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1525	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1530	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1531	POTENTIOMETER, 250 OHM	3110145	71450
R1532	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1535	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1540	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1541	POTENTIOMETER, 250 OHM	3110145	71450
R1542	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1545	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011	7115
R1546	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100	7115
R1548	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1549	RESISTOR, 909 OHM 1/4W 1% METAL FILM	3139099	7115
R1550	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1551	POTENTIOMETER, 250 OHM	3110145	71450
R1552	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1555	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R1570	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1556	RESISTORS, MATCHED SET 100 OHM	3201000	10597
R1560	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1561	POTENTIOMETER, 250 OHM	3110145	71450
R1562	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1565	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R1570	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1571	POTENTIOMETER, 250 OHM	3110145	71450
R1572	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1575	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R1580	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1581	POTENTIOMETER, 250 OHM	3110145	71450
R1582	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901	7115
R1585	RESISTOR, 2940 OHM 1/4W 1% METAL FILM	3132941	7115
R1600	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1601	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1605	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1606	RESISTOR, 10 OHM 1/4W 5% CARBON	3270100	1121
R1607	RESISTOR, 100 OHM 1/4W 5% CARBON	3270101	1121
R1621	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320	7115
R1622	RESISTOR, 11300 OHM 1/4W 1% METAL FILM	3131132	7115
R1623	POTENTIOMETER, 1K OHM TRIM	3110147	71450
R1624	RESISTOR, 10K OHM 1/4W 5% CARBON	3270103	1121
R1625	RESISTOR, 68 OHM 1/4W 5% CARBON	3270680	1121
R1626	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1627	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R1628	RESISTOR, 1000 OHM 1/4W 5% CARBON	3271102	1121
R1629	RESISTOR, 10000 OHM 1/4W 1% METAL FILM	3131002	7115
R1630	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R1631	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1632	RESISTOR, 16500 OHM 1/4W 1% METAL FILM	3131652	7115
R1633	RESISTOR, 324K OHM 1/4W 1% METAL FILM	3133243	7115
R1635	RESISTOR, 15K OHM 1/4W 5% CARBON	3270153	1121
R1640	RESISTOR, 11K OHM 1/4W 5% CARBON	3270113	1121
R1645	RESISTOR, 4300 OHM 1/4W 5% CARBON	3270432	1121
R1646	RESISTOR, 360 OHM 1/4W 5% CARBON	3270361	1121
R1650	RESISTOR, 160 OHM 1/4W 5% CARBON	3270161	1121
R1651	RESISTOR, 100K OHM 1/4W 5% CARBON	3270104	1121
R1652	RESISTOR, 5600 OHM 1/4W 5% CARBON	3270562	1121
R1655	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R1656	RESISTOR, 51 OHM 1/4W 5% CARBON	3270510	1121
R1660	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R1661	RESISTOR, 47 OHM 1/4W 5% CARBON	3270470	1121
R1662	RESISTOR, 787 OHM 1/4W 1% METAL FILM	3137870	7115
R1665	RESISTOR, 22 OHM 1/4W 5% CARBON	3270220	1121
R1669	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R1670	RESISTOR, 10K OHM 1/4W 5% CARBON	3270103	1121
R1671	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261	7115
R1672	RESISTOR, 15.8 OHM 1/4W 1% METAL FILM	3130158	7115
R1673	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
R1674	RESISTOR, 14300 OHM 1/4W 1% METAL FILM	3131432	7115
R1675	POTENTIOMETER, 500 OHM TRIM	3110142	71450
R1678	RESISTOR, 12100 OHM 1/4W 1% METAL FILM	3131212	7115

PART	DESCRIPTION	EXACT NO	MFG
R1677	RESISTOR, 121Ω OHM 1/4w 1% METAL FILM	3131212	7115
R1678	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R1679	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R1680	RESISTOR, 6810 OHM 1/4w 1% METAL FILM	3136811	7115
R1681	RESISTOR, 6810 OHM 1/4w 1% METAL FILM	3136811	7115
R1682	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R1683	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R1684	RESISTOR, 12100 OHM 1/4w 1% METAL FILM	3131212	7115
R1685	RESISTOR, 12100 OHM 1/4w 1% METAL FILM	3131212	7115
R1686	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R1687	RESISTOR, 45.3 OHM 1/4w 1% METAL FILM	3130453	7115
R1688	RESISTOR, 93.1 OHM 1/4w 1% METAL FILM	3130931	7115
R1689	RESISTOR, 287 OHM 1/4w 1% METAL FILM	3132870	7115
R1690	RESISTOR, 1270 OHM 1/4w 1% METAL FILM	3131271	7115
R1691	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1692	RESISTOR, 2740 OHM 1/4w 1% METAL FILM	3132741	7115
R1693	POTENTIOMETER, 250 OHM	3112145	71450
R1694	POTENTIOMETER, 100 OHM TRIM	3110141	71450
R1695	RESISTOR, 127 OHM 1/4w 1% METAL FILM	3131270	7115
R1696	RESISTOR, 210K OHM 1/4w 1% METAL FILM	3132103	7115
R1697	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1698	POTENTIOMETER, 100K OHM TRIM	3110143	71450
R1699	RESISTOR, 49.9 OHM 1/4w 1% METAL FILM	3130499	7115
R1700	RESISTOR, 1000 OHM 1/4w 5% CARBON	3072102	1121
R1701	RESISTOR, 68 OHM 1/4w 5% CARBON	3072680	1121
R1702	RESISTOR, 1000 OHM 1/4w 5% CARBON	3072102	1121
R1703	RESISTOR, 274K OHM 1/4w 1% METAL FILM	3132743	7115
R1704	RESISTOR, 274K OHM 1/4w 1% METAL FILM	3132743	7115
R1705	RESISTOR, 324K OHM 1/4w 1% METAL FILM	3133243	7115
R1706	RESISTOR, 1000Ω OHM 1/4w 1% METAL FILM	3131002	7115
R1707	RESISTOR, 332 OHM 1/4w 1% METAL FILM	3133320	7115
R1708	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R1709	RESISTOR, 16500 OHM 1/4w 1% METAL FILM	3131652	7115
R1710	RESISTOR, 16500 OHM 1/4w 1% METAL FILM	3131652	7115
R1715	RESISTOR, 15K OHM 1/4w 5% CARBON	3072153	1121
R1716	RESISTOR, 11K OHM 1/4w 5% CARBON	3072113	1121
R1725	RESISTOR, 160 OHM 1/4w 5% CARBON	3072161	1121
R1726	RESISTOR, 4300 OHM 1/4w 5% CARBON	3072432	1121
R1727	RESISTOR, 360 OHM 1/4w 5% CARBON	3072361	1121
R1730	RESISTOR, 100K OHM 1/4w 5% CARBON	3072104	1121
R1731	RESISTOR, 5600 OHM 1/4w 5% CARBON	3072562	1121
R1735	RESISTOR, 51 OHM 1/4w 5% CARBON	3072510	1121
R1736	RESISTOR, 51 OHM 1/4w 5% CARBON	3072510	1121
R1742	RESISTOR, 10K OHM 1/4w 5% CARBON	3072103	1121
R1745	RESISTOR, 22 OHM 1/4w 5% CARBON	3072220	1121
R1750	RESISTOR, 22 OHM 1/4w 5% CARBON	3072220	1121
R1751	RESISTOR, 47 OHM 1/4w 5% CARBON	3072470	1121
R1752	RESISTOR, 681 OHM 1/4w 1% METAL FILM	3136812	7115
R1753	RESISTOR, 681 OHM 1/4w 1% METAL FILM	3136812	7115
R1760	POTENTIOMETER, 500 OHM 2w	3112332	44655
R1761	RESISTOR, 45.3 OHM 1/4w 1% METAL FILM	3132453	7115
R1762	RESISTOR, 562 OHM 1/4w 1% METAL FILM	3135620	7115
R1763	POTENTIOMETER, 2.5K OHM 2w	3112329	44655
R1764	RESISTOR, 2320 OHM 1/4w 1% METAL FILM	3132321	7115
R1765	RESISTOR, 2740 OHM 1/4w 1% METAL FILM	3132741	7115
R1766	POTENTIOMETER, 250 OHM	3112145	71450

PART	DESCRIPTION	EXACT NO	MFG
R1802	RESISTOR, 2000 OHM 1/4w 5% CARBON	3072202	1121
R1806	RESISTOR, 274K OHM 1/4w 1% METAL FILM	3132743	7115
R1807	RESISTOR, 274K OHM 1/4w 1% METAL FILM	3132743	7115
R1808	RESISTOR, 1000 OHM 1/4w 5% CARBON	3072102	1121
R1809	RESISTOR, 324K OHM 1/4w 1% METAL FILM	3133243	7115
R1810	RESISTOR, 332 OHM 1/4w 1% METAL FILM	3133320	7115
R1811	RESISTOR, 1000Ω OHM 1/4w 1% METAL FILM	3131002	7115
R1812	POTENTIOMETER, 5K OHM TRIM	3110149	71450
R1813	RESISTOR, 16500 OHM 1/4w 1% METAL FILM	3131652	7115
R1814	RESISTOR, 16500 OHM 1/4w 1% METAL FILM	3131652	7115
R1820	RESISTOR, 15K OHM 1/4w 5% CARBON	3072153	1121
R1821	RESISTOR, 11K OHM 1/4w 5% CARBON	3072113	1121
R1825	RESISTOR, 160 OHM 1/4w 5% CARBON	3072161	1121
R1826	RESISTOR, 4300 OHM 1/4w 5% CARBON	3072432	1121
R1827	RESISTOR, 360 OHM 1/4w 5% CARBON	3072361	1121
R1830	RESISTOR, 100K OHM 1/4w 1% METAL FILM	3131003	7115
R1831	RESISTOR, 5600 OHM 1/4w 5% CARBON	3072562	1121
R1835	RESISTOR, 51 OHM 1/4w 5% CARBON	3072510	1121
R1836	RESISTOR, 51 OHM 1/4w 5% CARBON	3072510	1121
R1840	RESISTOR, 68 OHM 1/4w 5% CARBON	3072680	1121
R1841	RESISTOR, 10K OHM 1/4w 5% CARBON	3072103	1121
R1845	RESISTOR, 10 OHM 1/4w 5% CARBON	3072100	1121
R1846	RESISTOR, 1500 OHM 1/4w 1% METAL FILM	3131581	7115
R1847	RESISTOR, 249 OHM 1/4w 1% METAL FILM	3132490	7115
R1848	POTENTIOMETER, 250 OHM	3112145	71450
R1850	RESISTOR, 10 OHM 1/4w 5% CARBON	3072100	1121
R1855	RESISTOR, 10 OHM 1/4w 5% CARBON	3072100	1121
R1858	RESISTOR, 10 OHM 1/4w 5% CARBON	3072100	1121
R1860	RESISTOR, 150 OHM 1/4w 5% CARBON	3072151	1121
R1861	RESISTOR, 150 OHM 1/4w 1% METAL FILM	3131502	7115
R1862	RESISTOR, 26.1 OHM 1/4w 1% METAL FILM	3132261	7115
R1863	RESISTOR, 26.1 OHM 1/4w 1% METAL FILM	3132261	7115
R1864	RESISTOR, 34.8 OHM 1/4w 1% METAL FILM	3133484	7115
R1865	RESISTOR, 41.2 OHM 1/2w 1% METAL FILM	3100412	7115
R1866	RESISTOR, 41.2 OHM 1/2w 1% METAL FILM	3100412	7115
R1867	RESISTOR, 10.2 OHM 1/8w 1% METAL FILM	3180102	7115
R1868	RESISTOR, 46.4 OHM 1/2w 1% METAL FILM	3100464	7115
R1869	RESISTOR, 46.4 OHM 1/2w 1% METAL FILM	3100464	7115
R1870	RESISTOR, 3.16 OHM 1/8w 1% DEP. CARBON	3193160	7115
R1895	RESISTOR, 1690 OHM 1/4w 1% METAL FILM	3131691	7115
S0101	SWITCH, TOGGLE SPDT	2601103	100005
S0102	SWITCH, SLIDE	2600323	10597
S0200	CONCENTRIC SWITCH & POTENTIOMETER	2600313	71450
S0350	SWITCH, SLIDE DPDT	2600212	76854
S0375	SWITCH, BCD ROTARY	2620324	10597
S0400	SWITCH, PUSH BUTTON	2600355	71590
S0600	SWITCH, ROTARY	2600357	76854
S0700	SWITCH, PUSH BUTTON	2600354	10597
S1400	SWITCH, THUMBWHEEL	2600365	10597
S1500	SWITCH, ROTARY	2600357	76854
S1700	SWITCH, PUSH BUTTON	2600354	10597
T0100	TRANSFORMER, POWER	1200043	10597

SECTION 6

BOARD LAYOUTS

AND

SCHEMATICS

FOREWORD TO SCHEMATICS

To facilitate quick reference to interconnections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection.

EXACT
443-0MM
11-6-72
HIGH FREQ ADJ
LOW FREQ ADJ
SEARCH RANGE ADJ
DRIVE ADJ
-CUR ADJ
+CUR ADJ
MULT ADJ
SQUARE DC
SQUARE AMPL
PRE AMP BAL
SINE SHAPER DC
SINE DC
SINE BAL AMP
TRI DC
TRI AMPL
1ST AMPL ADJ
2ND-2ND ADJ
2ND-3RD ADJ
2ND AMPL ADJ
3RD-2ND ADJ
3RD-3RD ADJ
3RD AMPL ADJ
FREQ OFFSET ADJ
SINE ADJ
+DRIVE ADJ
CROW BAR
+15V ADJ
-15V ADJ
+20V ADJ
-20V ADJ
-2.25V ADJ
+2.25V ADJ
P.A. BAL
COM

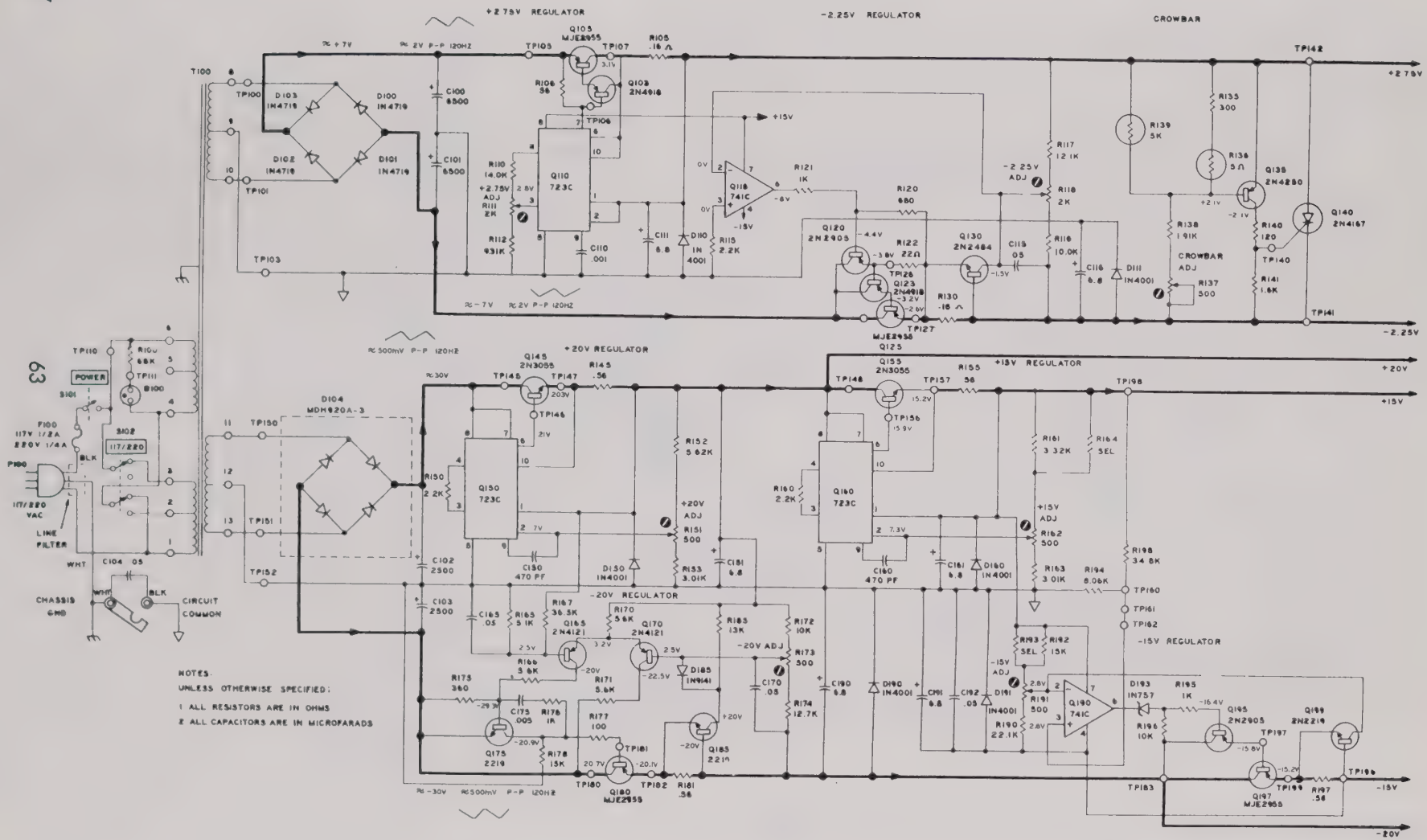
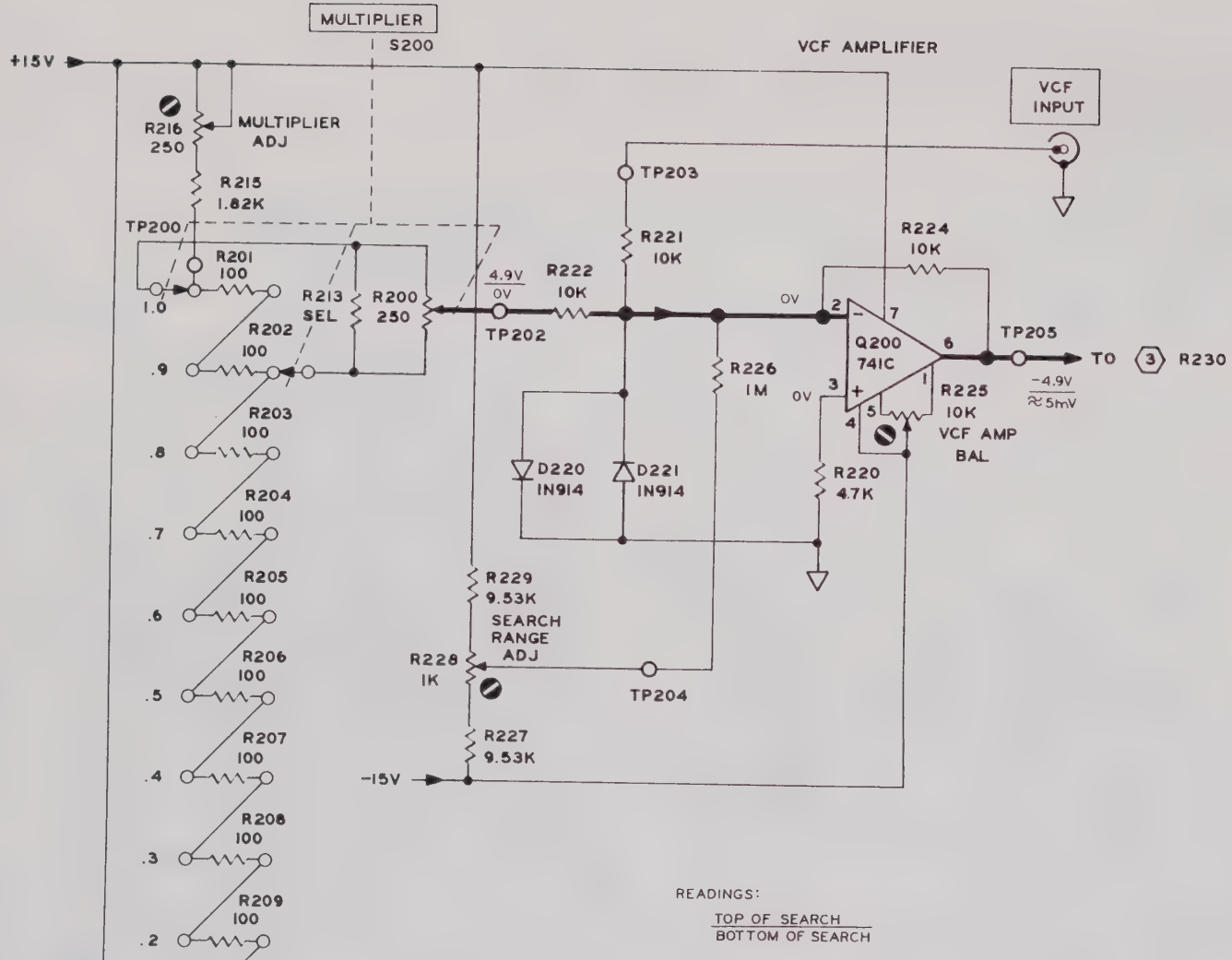
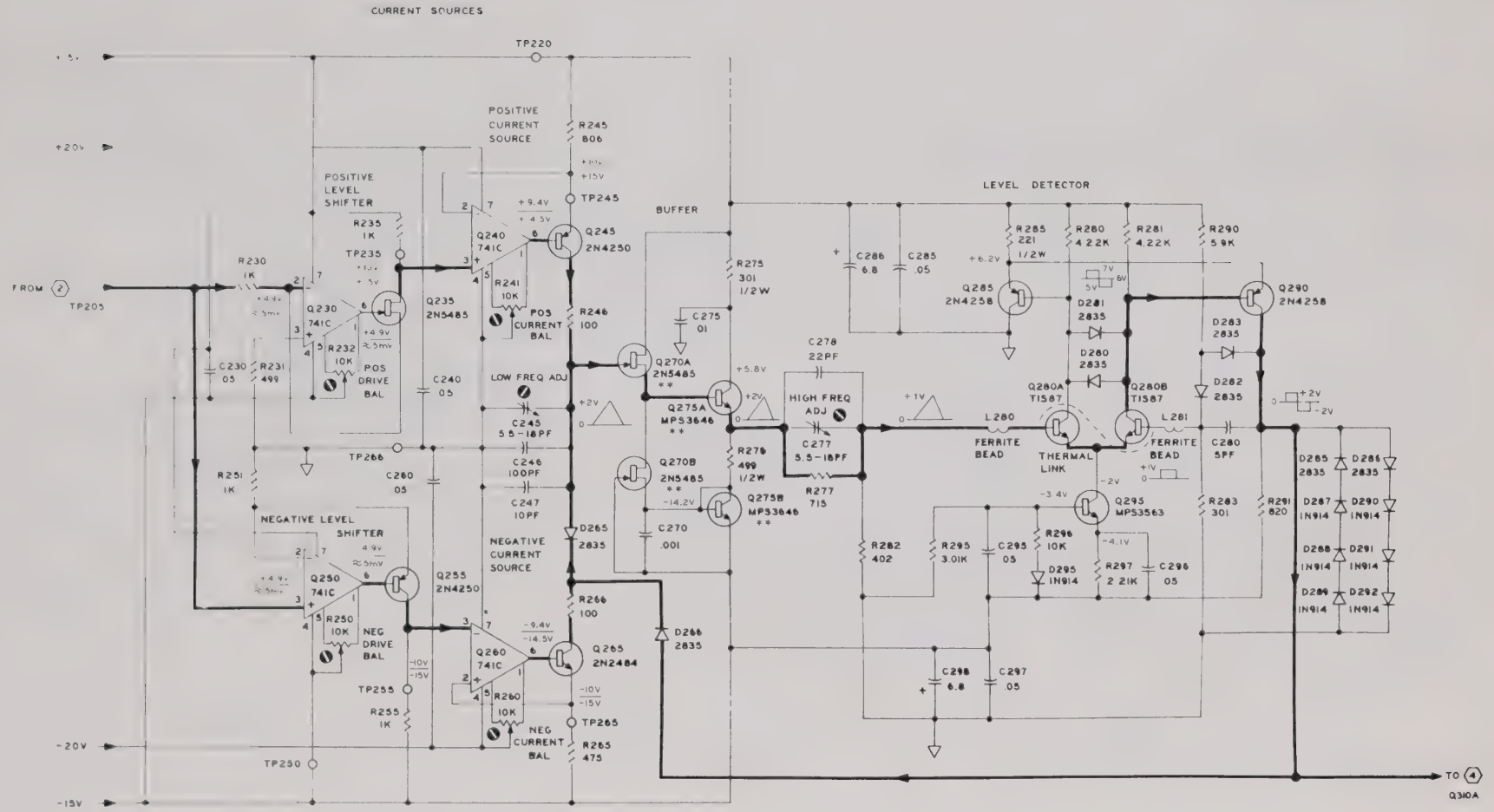


FIG 6 2.0
SCHEMATIC DIAGRAM MODEL 337
POWER SUPPLIES
REV A



NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS IN OHMS

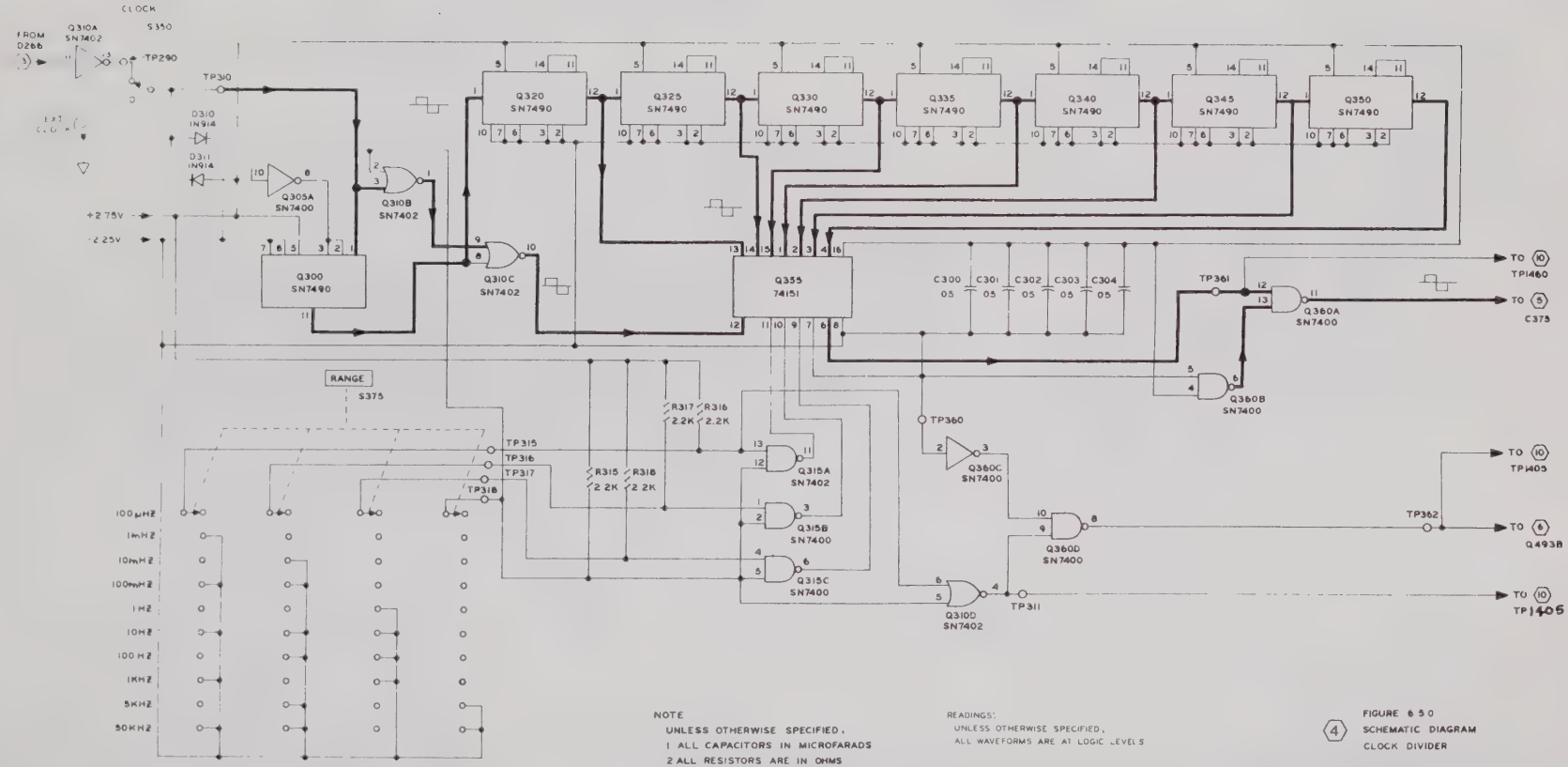
(2) FIGURE 6.3.0
SCHEMATIC DIAGRAM
FREQUENCY CONTROL



NOTES
UNLESS OTHERWISE SPECIFIED
1 ALL RESISTORS IN OHMS
2 ALL CAPACITORS IN MICROFARADS
3 ** MATCHED PAIR

READINGS
TOP OF SEARCH
BOTTOM OF SEARCH

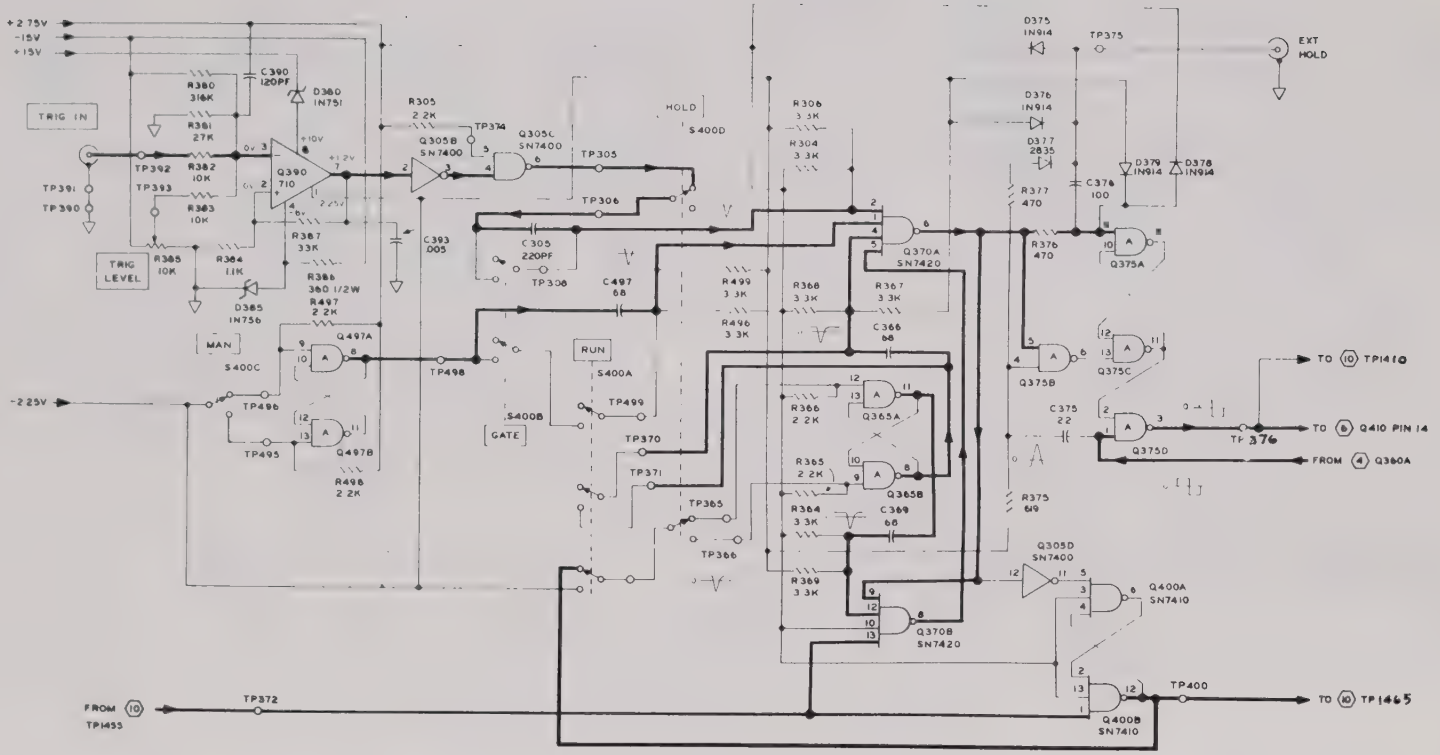
3 FIGURE 6 4 0
SCHEMATIC DIAGRAM
GENERATOR LOOP
REV B



NOTE
UNLESS OTHERWISE SPECIFIED,
1 ALL CAPACITORS IN MICROFARADS
2 ALL RESISTORS ARE IN OHMS

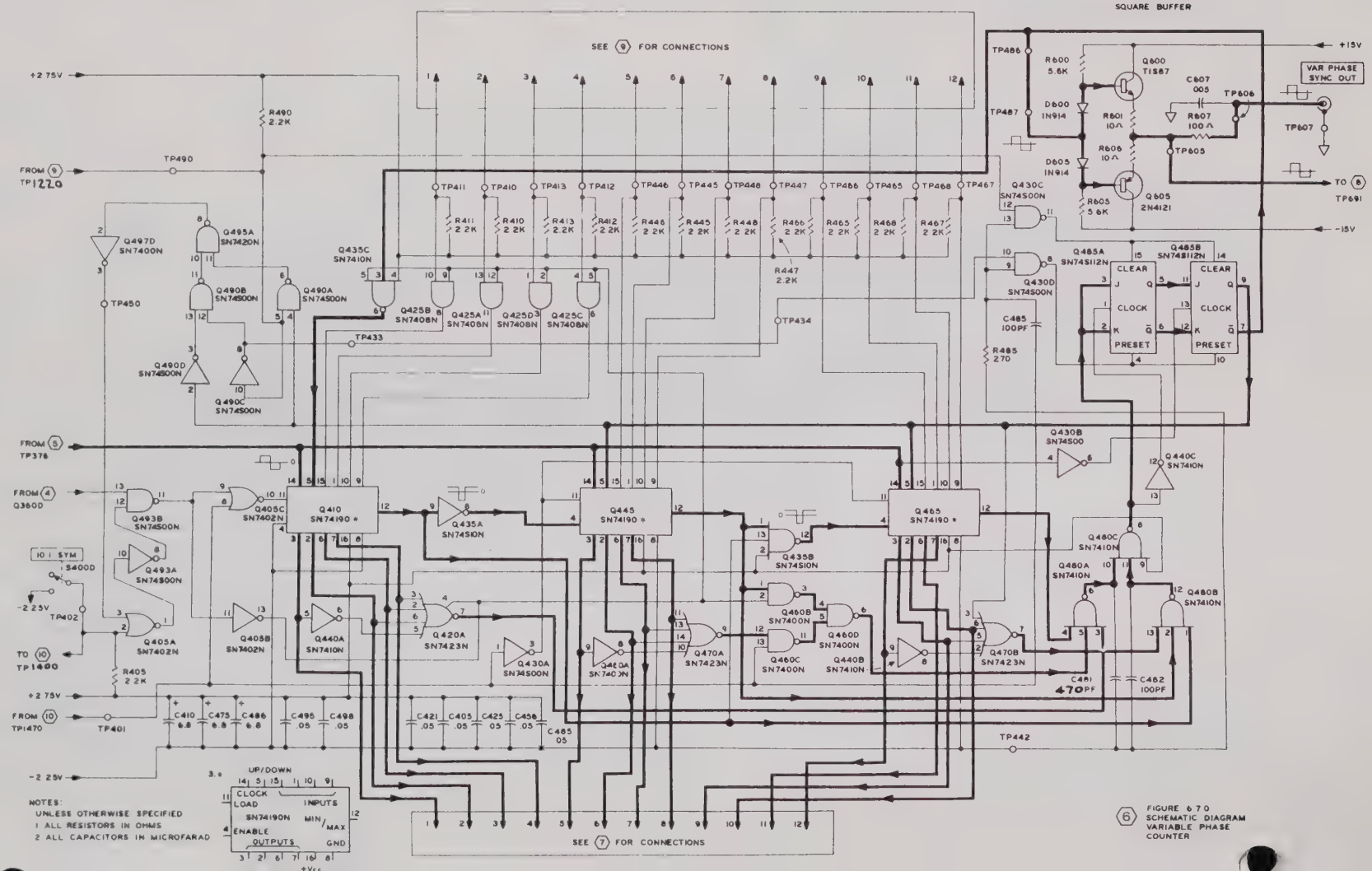
READINGS:
UNLESS OTHERWISE SPECIFIED,
ALL WAVEFORMS ARE AT LOGIC LEVELS

(4) FIGURE 8.5.0
SCHEMATIC DIAGRAM
CLOCK DIVIDER

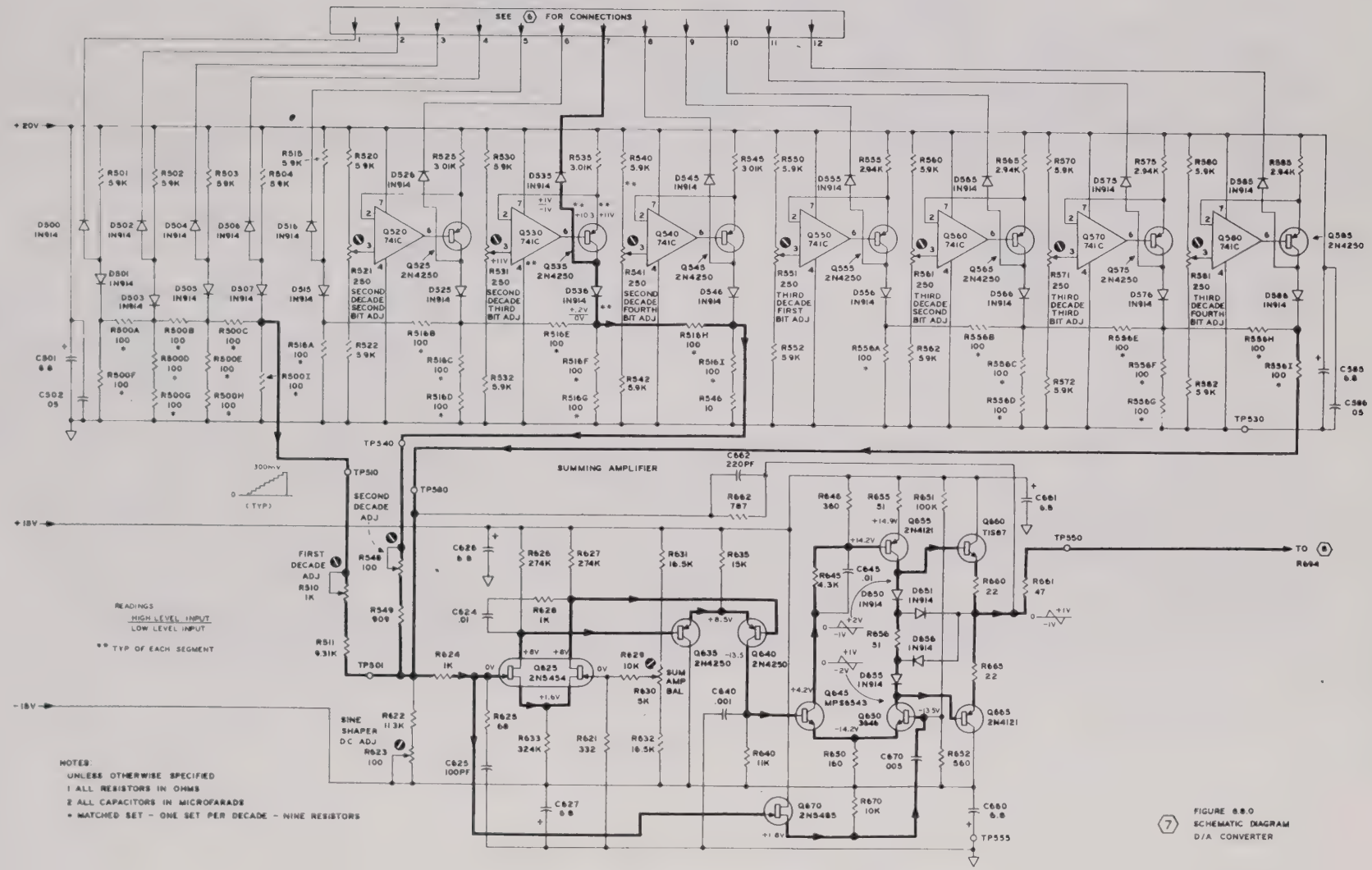


NOTES
UNLESS OTHERWISE SPECIFIED.
1 ALL CAPACITORS IN PICOFARADS
2 A - SN7400

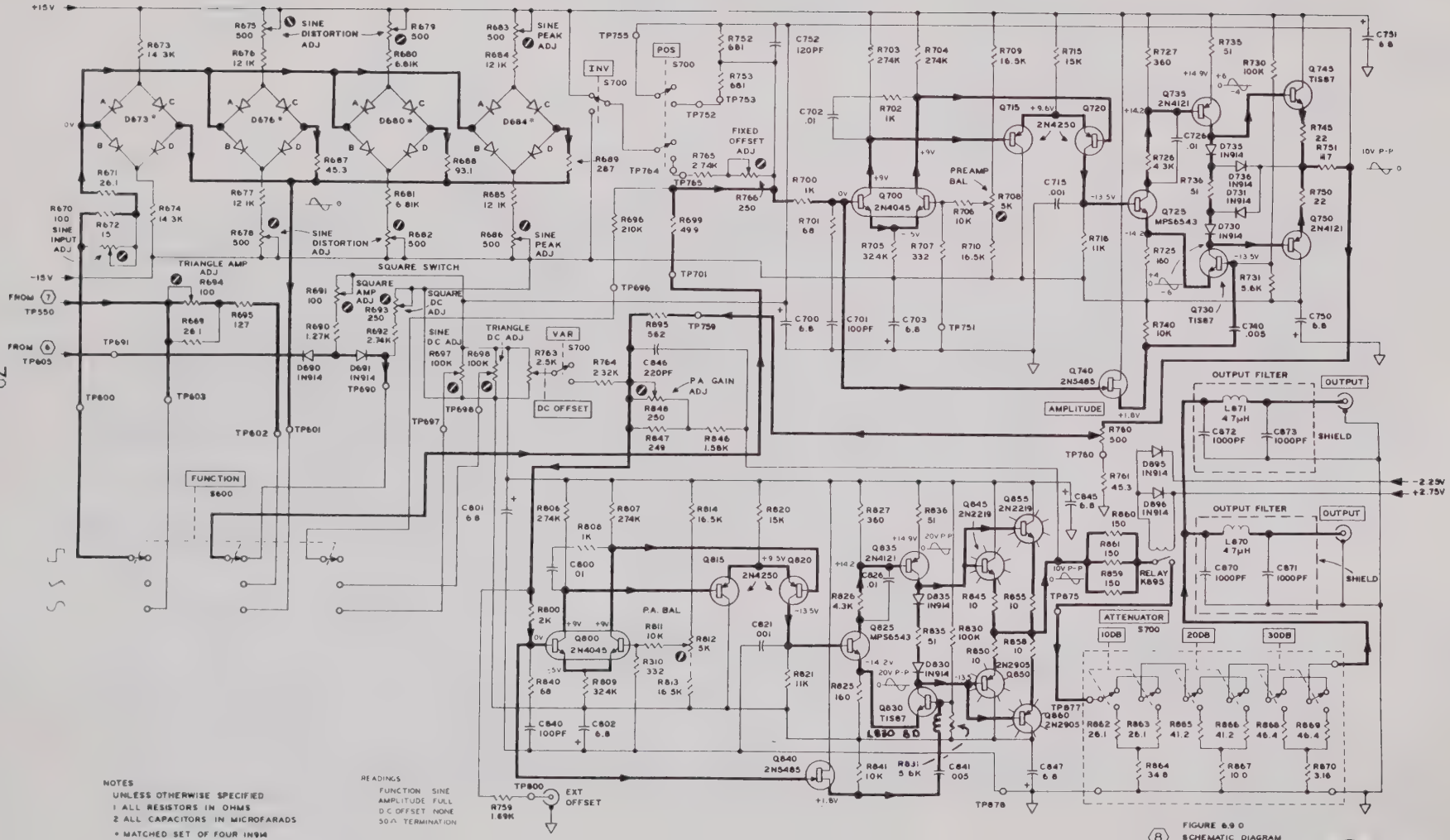
(5) FIGURE 6-6-0
SCHEMATIC DIAGRAM
CLOCK CONTROL



(6) FIGURE 6 7 0
SCHEMATIC DIAGRAM
VARIABLE PHASE
COUNTER



(7) FIGURE 6.8.0
SCHEMATIC DIAGRAM
D/A CONVERTER



8 FIGURE 6-9 0
SCHEMATIC DIAGRAM
VARIABLE PHASE

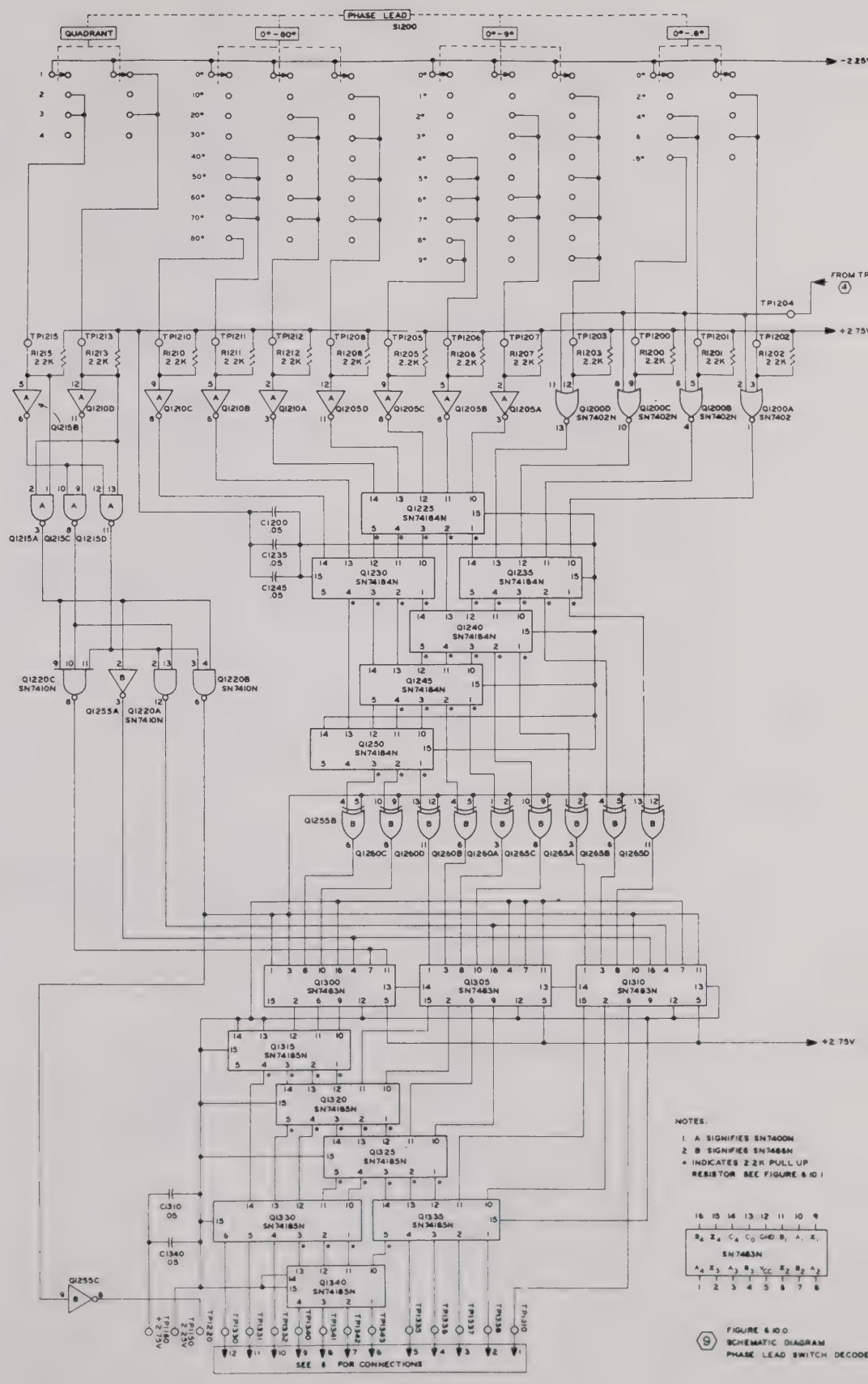
FIGURE 6.10.1

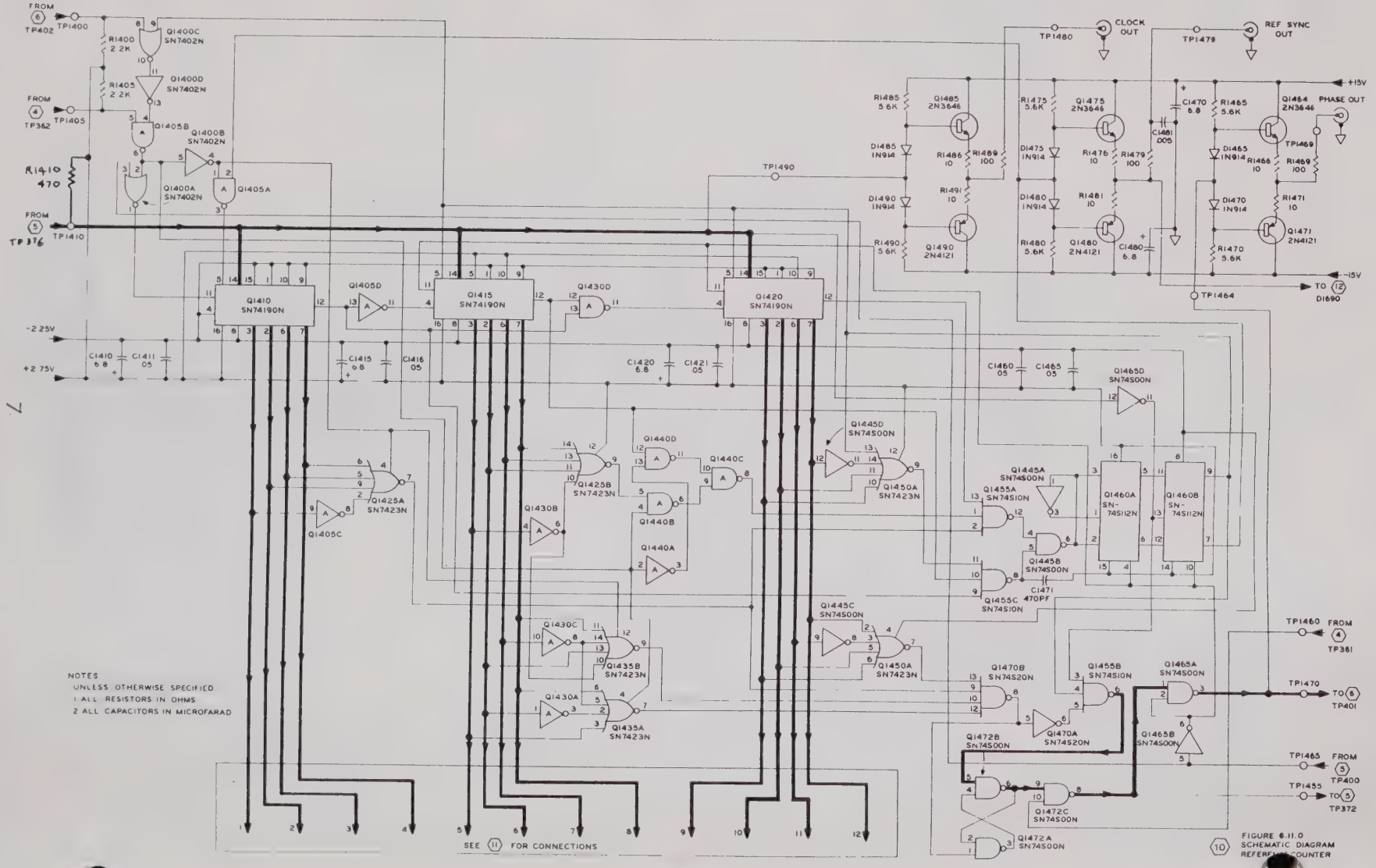
RESISTOR NUMBERS FOR FIGURE 6.10.0

ASSOCIATED DEVICE	PIN NO.	RESISTOR NO.
Q1225	1	R1225
"	2	R1226
"	3	R1227
"	4	R1228
"	5	R1229
Q1230	1	R1230
"	2	R1231
"	3	R1232
"	4	R1233
Q1235	1	R1235
"	2	R1236
"	3	R1237
"	4	R1238
"	5	R1239
Q1240	1	R1240
"	2	R1241
"	3	R1242
"	4	R1243
"	5	R1244
Q1245	1	R1245
"	2	R1246
"	3	R1247
"	4	R1248
"	5	R1249
Q1250	1	R1250
"	2	R1251
"	3	R1253
Q1315	1	R1315
"	2	R1316
"	3	R1317
"	4	R1318
Q1320	1	R1320
"	2	R1321
"	3	R1322
"	4	R1323
"	5	R1324
"		

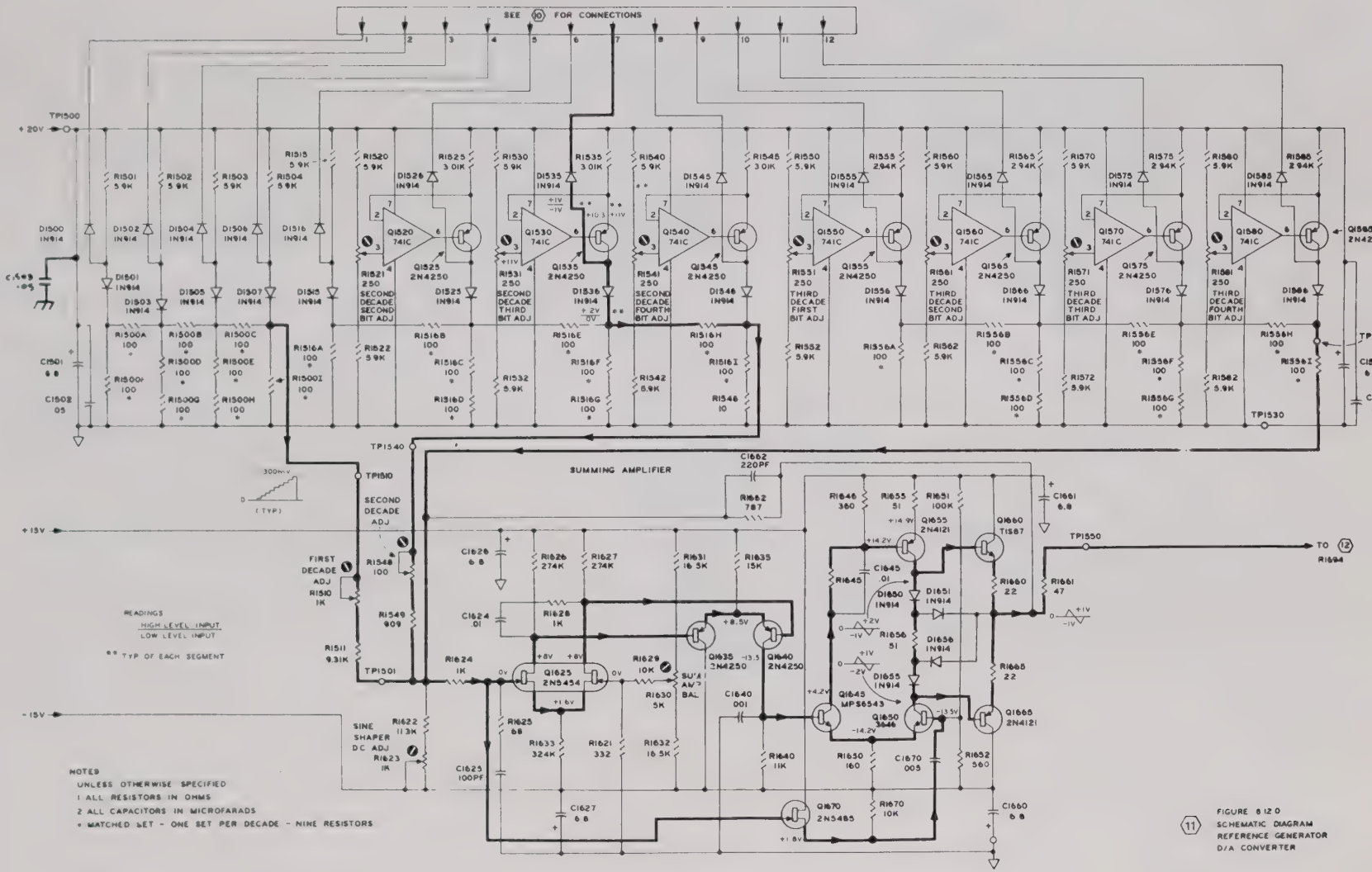
FIGURE 6.10.1 (Continued)

ASSOCIATED DEVICE	PIN NO.	RESISTOR NO.
Q1325	1	R1325
"	2	R1326
"	3	R1327
"	4	R1328
"	5	R1329
Q1330	1	R1330
"	2	R1331
"	3	R1332
Q1335	5	R1335

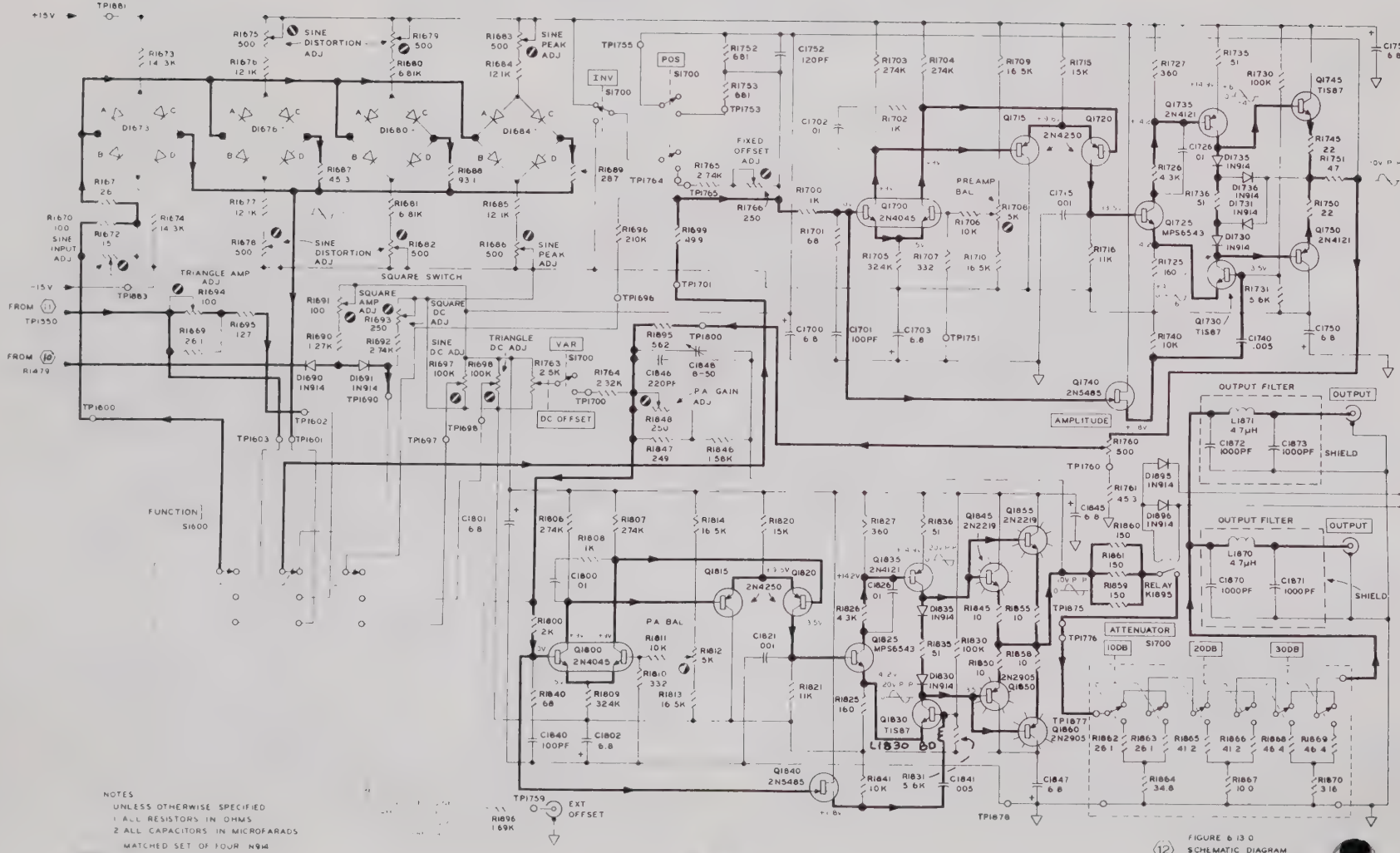

PHASE LEAD
S1200
QUADRANT
0°-80°
0°-9°
0°-.6°
+2.25V
FROM TP
4
TP1204
+2.75V
TP1215
TP1213
TP1210
TP1211
TP1212
TP1208
TP1205
TP1206
TP1207
TP1203
TP1200
TP1201
TP1202
R1215 2.2K
R1213 2.2K
R1210 2.2K
R1211 2.2K
R1212 2.2K
R1208 2.2K
R1205 2.2K
R1206 2.2K
R1207 2.2K
R1203 2.2K
R1200 2.2K
R1201 2.2K
R1202 2.2K
Q1215B
Q1210D
Q1210C
Q1210B
Q1210A
Q1205D
Q1205C
Q1205B
Q1205A
Q1200D SN7402N
Q1200C SN7402N
Q1200B SN7402N
Q1200A SN7402
Q1215A
Q1215C
Q1215D
C1200 .05
C1235 .05
C1245 .05
Q1225 SN74184N
Q1230 SN74184N
Q1235 SN74184N
Q1240 SN74184N
Q1245 SN74184N
Q1250 SN74184N
Q1220C SN7410N
Q1220B SN7410N
Q1255A
Q1220A SN7410N
Q1255B
Q1260C
Q1260D
Q1260B
Q1260A
Q1265C
Q1265A
Q1265B
Q1265D
Q1300 SN7483N
Q1305 SN7483N
Q1310 SN7483N
Q1315 SN74185N
Q1320 SN74185N
Q1325 SN74185N
Q1330 SN74185N
Q1335 SN74185N
Q1340 SN74185N
C1310 .05
C1340 .05
Q1255C
TP1320
TP1331
TP1332
TP1330
TP1341
TP1342
TP1343
TP1335
TP1336
TP1337
TP1338
TP1310
TP1350 +2.25V
TP1351 +2.75V
SEE 6 FOR CONNECTIONS
+2.75V
NOTES:
1. A SIGNIFIES SN7400N
2. B SIGNIFIES SN7486N
• INDICATES 2.2K PULL UP RESISTOR SEE FIGURE 6.10.1
SN7483N
9
FIGURE 6.10.0
SCHEMATIC DIAGRAM
PHASE LEAD SWITCH DECODE



10 FIGURE 6.11.0
SCHEMATIC DIAGRAM
REFERENCE COUNTER



(11) FIGURE 8.12.0
SCHEMATIC DIAGRAM
REFERENCE GENERATOR
D/A CONVERTER



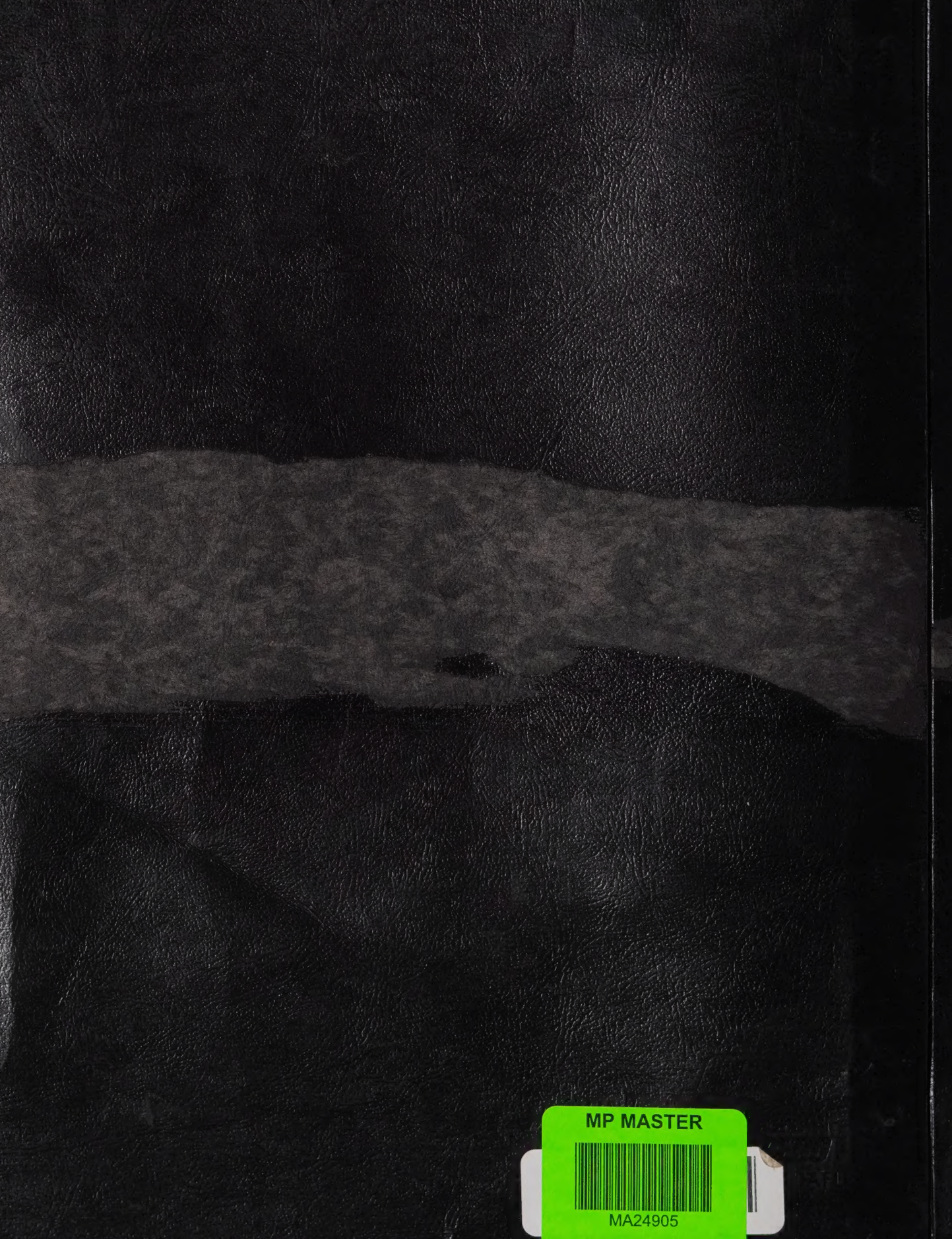
12 FIGURE 6 13 0
SCHEMATIC DIAGRAM
REFERENCE GENERATOR
SIGNAL SHAPING AND POWER

SECTION 7

ADDENDA

At EXACT we continually strive to incorporate latest electronic developments by adding circuit and component improvements to our instrument line as they are developed and tested.

At times, due to printing and shipping requirements, change information is not entered in the main body of the manual. It therefore may contain new change information in the following pages of this section. If change pages do not appear in this section, your manual is correct as printed.


MP MASTER
MA24905